CRITICAL ASSESSMENT OF RAISING THE BASIC LEVEL OF WATER SERVICES

Report to the
Water Research Commission

by

Ciaran Chidley, Riaan Taljaard and Clement Longondjo
Nemai Consulting CC

WRC Report No. 1892/1/13
ISBN 978-1-4312-0428-1

May 2013

Obtainable from

Water Research Commission
Private Bag X03
GEZINA, 0031

orders@wrc.org.za or download from www.wrc.org.za

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EXECUTIVE SUMMARY

The 1994 Water Services Policy White Paper focused on the institutions and mechanisms needed to remedy the backlogs in the country and in 1996 the Constitution introduced a human rights dimension for access to adequate and sustainable water supply and services. In 1997 the Water Services Act ensured the right of access to basic water supply and sanitation, and also provided a regulatory framework for the establishment of water services institutions to provide these services. In 2000 the Free Basic Water Policy was introduced which stated that municipalities had to provide a minimum of 25 litres of potable water per person per day (or 6,000 litres per household per month) within 200 metres of a household, of uninterrupted water services for more than seven days in any year; and with a minimum flow of 10 litres per minute in the case of communal water points. It is clear that the evolution of water sector policies in South Africa demonstrates government's appreciation of the role of water in improving the livelihood of all South Africans. However, even with a strong and enabling policy and legislative environment, it is well acknowledged that people cannot move forward on just a basic level of service. At the Johannesburg "2003 Water, Poverty and Productive Uses of Water at the Household Level" symposium, it was acknowledged households needed at least 50 to 200 litres per capita per day of water for both domestic and small-scale multiple uses. Direct and indirect benefits of a higher level of service include improvements in population health, better nutrition, improved education outcomes, better gender equality through reduced burden on female members of households and a decrease in economic vulnerability of poorer households. The lack of access to safe water and hygiene practices is the third most significant risk factor for poor health in South Africa. Diarrhoeal disease, for example, is widely recognised as the principal result of inadequate water. Sustainable access to water alleviates collection responsibilities for the community, especially women and children. In 2007 the Department of Water Affairs (DWA) commissioned a study to quantify the benefit: cost ratio of a Higher Level of Water Supply Standards. The study found that the benefit:cost ratio for moving an unsafe water supply facility to low pressure restricted yard standpipe at 6000 l/house/month is 43:9. Although the DWA study clearly illustrates the significant importance of providing a HLOS it does not unpack the financial implications of a HLOS on a municipality. The WRC study, the "Critical Assessment of Raising the Basic Level of Water Services" builds on the DWA study and takes the study forward by understanding the following:

- Assessing and quantifying the implications related to raising the basic level of water services on a municipality.
- Identifying potential opportunities, problems and challenges arising with water improvement projects for a municipality.
- Identifying alternate strategies to raising the basic level of water services.
- Developing a financial model on raising the basic level of water services.
- Recommending best practices in terms of addressing different service level scenarios and identifying further research needs'

The study assumes that basic water supply is defined as 25 litres per person per day based on 8 people per household or 6 000 litres per month and basic sanitation is defined as the provision of a toilet which is safe, reliable, environmentally sound, well ventilated, provide privacy and protection against weather, keeps odour to a minimum and prevents entry and exit of flies and other disease-carrying pests. While the current Free Basic Water and

Sanitation policy in South Africa stipulates that the basic levels, as defined above, as also the free levels, the two should not be confused or used interchangeably. The report investigates raising the basic level of water services and is not limited to raising the free basic water allowance.

A comprehensive financial and technical model was developed to determine the implications of raising the basic level of service for a municipality. The model allows users to input required water services scenarios and the output is given as a cost for each required level of service. In addition to the cost implications for the level of service, the model also raises a number of flags to highlight issues that cannot be captured as a cost. The outputs of the models can be extrapolated to a national level to highlight some potential national level implications and conclusions.

The model was tested on the Ditsobotla Local Municipality (DLM), formerly known as the Lichtenburg Municipality, which is within the Ngaka Modiri Molema District Municipality in the North-West Province. The municipality was selected because it has both rural and urban areas and has a variety of water supply systems.

Below is a summary of a few water service level scenarios.

Scena-rio	Description	Water Supply Level [kl/hh/month]	Additio-nal Staff	Additional Capital/ Household [R/hh]	Additional Monthly Costs [R/hh/month]
1a	All households with RDP connection, dry sanitation	14	32	1 171.17	21.13
1b	All households with RDP connection, water treatment works source, dry sanitation	14	43	1 468.20	25.88
2a	All households with yard connection, dry sanitation	15	22	1 674.99	34.91
2b	All households with yard connection, water treatment works source, dry sanitation	15	43	1 972.02	39.65
2c	All households with yard connection, water treatment works source and domestic meters, dry sanitation	15	43	3 786.92	54.84
3a	All households with house connection, waterborne sanitation	34	467	9 544.73	246.28
3b	All households with house connection, water treatment works source, waterborne sanitation	34	488	9 841.77	251.05

3c	All households with house connection, water treatment works source and domestic meters, waterborne sanitation	34	488	11 656.67	266.84

The financial implications for the DLM of increasing the level of water supply from a RDP standard to a yard level water supply with dry sanitation are marginal yet the benefits remain significant. However, metering all yard connections increases the cost significantly hence the DLM would need to decide on more cost effective strategies to control consumption either with soft approach like training and education or technical solutions like flow and pressure control, etc. This result is understandable given that the installation of meters at the DLM level is not very far advanced. For a full service to be provided to the entire community, a substantial increase in the national costs per household, will take place. The additional staff required to move towards a full level of service should be considered by policy makers as a shortage of skills at WWTW and WTW is a very real concern for municipalities.

Following the development of the model for the DLM, the model was then applied on a national scale. Two applications of the model were carried out. The first application was the so-called "Roll-Up Method, the second was the so-called "Step Method".

The "roll-up" model indicates that the costs for bringing the entire 2001 population up to a full level of service would be in the order of R110 billion. Once this infrastructure has been constructed, the annual costs of servicing and maintaining it would be in the order of R26 billion. The results of the "step-up"-model indicate that the total capital costs for bringing the entire 2001 population up to a full level of service would be in the order of R145 billion.

The model shows that the progress up the steps of the water ladder is not one of smooth transitions. Indications are that the following per household costs would be applicable:

Water Ladder Step		**Per Household Cost [R]**
Starting Level of Service	**Ending Level of Service**	
No service	Standpipe & Communal taps, VIP latrines	7 730.68
Standpipe & Communal taps	Yard Taps, VIP latrines	3 520.44
Yard Taps	House Connections, Waterborne sanitation	15 972.99

South Africa had made the initial decision to make the first step on the ladder in 1994 and the decision to take subsequent steps has not been made. **The model concludes that bringing all households to a Yard Tap level of service with a minimum sanitation level of VIP latrines, would have half the cost implications of the 1994 decision.** In contrast, the step beyond this level, to house connections and waterborne sewerage would have significant cost implications. In light of the cost increases for water services, the distribution of the burden to pay for these costs would have to be considered. Currently water services practice is to provide a free basic service. The level of this service – communal standpipes and 6 000 l/hh/month, is provided for free – there is currently no need to differentiate between the basic service and the free aspect of the service. This situation is the result of the human rights consideration that the minimum quantity and quality of water supply should be free to all RSA residents. In moving up the water services ladder, this separation would have to be made. Once the human rights requirement has been fulfilled, moving above this level could involve households shouldering some of the costs of the improved level of service. The literature review shows that one of the benefits of having water available is an improvement in health and therefore lifespan. The economic justification for improving water supply thus runs along the lines of it reducing the health care burden of the state as well as extending the productive lifespan of the population. This argument applies especially to the rural poor. However, once water supplies rise above what is needed to fulfil these economic arguments, water supply becomes a "normal" good that can be supplied at a cost; the use of the water derived for its users a benefit greater than the cost.

Thus the new basic level of supply need not be free. The free component could be left at the standpipe and 6 000 l/hh/month level, whilst tariffs are charged for additional water supplies.

To take the line of reasoning further, it is necessary to examine the main cost drivers of waters services, as shown in the model. The following Tables presents a typical percentage cost breakdown for the various pieces of infrastructure for two scenarios.

Infrastructure Component	% of total cost	
	All households with yard connection, water treatment works source and domestic metres, dry sanitation	All households with house connection, waterborne sanitation
Household sanitation	34.2%	35.5%
Internal reticulation	33.7%	28.4%
Water pipelines (bulk)	9.9%	6.1%
Sewage Treatment Works	7.5%	19.4%
Elevated storage	5.4%	3.4%
Metering	4.9%	3.0% *
Water Treatment Works	2.7%	0.2% *
Sewer pipelines (bulk)	1.2%	3.6%
Boreholes	0.6%	0.4%

* Scenario 3a excludes upgrading these items, so these figures are un-representative

The Table demonstrates that the major costs of both of these scenarios are the household level infrastructure components. Economies of scale apply to the larger, common use, infrastructure components. The household level infrastructures are the items whose primary purpose is to improve the quality of the service. **To move from standpipes to yard taps, at**

the same volume of water supplied, will be far more expensive than to leave the standpipes in place and increase the volume of water supplied. Obviously the volume of water supplied will have an upper limit, beyond which larger supply pipes will have to be installed, but twenty-four hour off-takes can be carried out to great effect, to delay this step.

Thus, it is submitted that the increase of the volume of water does not incur the main costs. The major costs are incurred for the improvement of the physical infrastructure necessary to increase the quality of the service. Therefore it is possible to increase the free basic volume of water, but not to increase the free basic quality of water service. It is the quality of service improvements that would require household financial participation, not an increase in the free basic volume of water.

In this light, the concepts of free and basic water should be separated. The free water supply could be move up to standpipe connections and a higher volume of water service. The basic water supply could be set to yard connections and VIP latrines for example. Funding for this supply would have to be sourced, at least partially, from affected households.

Owing to the requirement for greater financial participation from households in the provision of water services, the setting of a national policy with regards to the basic water supply is seen to be counter-productive. Improvements in the basic water supply should be made in consultation and participation with communities, the results of this consultation will not be uniform across the country. Various factors will influence community decisions – not least of which are the costs of improved supply, but this would include raw water availability and the other uses to which water could be put at household level. Hence a single basic water services standard would run the risk of not obtaining household participation. Thus the costs will fall to external sources of funding – either cross-subsidisation or from the treasuries of the various tiers of government. Once this occurs, and the users of the water services do not want to be financially invested in the supply, the question will arise as to whether other uses for the external funding might be more productive.

The model indicates the following national level costs for moving up the water services ladder.

Water Ladder Step		**National Capital Cost [R million]**
Starting Level of Service	**Ending Level of Service**	
No service	Standpipe & Communal taps, VIP latrines	12 519
Standpipe & Communal taps	Yard Taps, VIP latrines	14 263
Yard Taps	House Connections, Waterborne sanitation	118 027
	Total	144 811

The additional human resources required for a move to a full waterborne level of service is estimated at 13 400 people. This is in addition to the 40 000 people estimated by the model required to service the 2001 infrastructure. The Table below summarises the total human resources requirements for the move to a full level of service.

Province	Total Human Resources Estimate
Eastern Cape	7 644
Free State	3 583
Gauteng	8 438
KwaZulu-Natal	11 143
Mpumalanga	3 981
North West	5 384
Northern Cape	1 892
Limpopo	6 508
Western Cape	4 857
South Africa	53 428

A skilled human resource base is essential to ensure that the full lifespan of the infrastructure is realised. A lack of regular maintenance by skilled personal serves to reduce the economic life of the infrastructure, which has very serious implications for the lifecycle costs of moving up the water services ladder.

The Table below details the combined return flows for the various levels of service.

Water Ladder Step		Average Water Demand [kl/hh]	Average Return Flow [kl/hh]
Starting Level of Service	Ending Level of Service		
No service	Standpipe & Communal taps, VIP latrines	14	5
Standpipe & Communal taps	Yard Taps, VIP latrines	15	5
Yard Taps	House Connections, Waterborne sanitation	34	30

Return flows for the first two steps are relatively low proportions of the total water demand for the first two steps up the water services ladder. These figures are because most of the households in the sample have a VIP latrine level of service, while the remaining population, with a higher level of service is contributing via conventional sanitation flows. Hence the total flow is biased towards grey water at these low levels of service.

Further research needs to deal specifically with the constraints and enhances the opportunities include:

- *Policy research* – strategic policy research to enhance the improvement of national level policies and processes, also to enhance the realization of broader poverty and health implications of raising the basic level of water services at three levels of government. More research is needed to determine the feasibility of separating free basic water and new definition of a basic level of service. Also, research is required to understand the implications of different basic levels of service linked to settlement. A one fit all definition may not be the cost effective solution for the country.
- *Socio-economic and market research* – research on education, awareness and marketing, for both users and providers will support the process; benefit-cost analysis for alternative water technologies or extra water volume, taking into account affordability, accessibility, maintenance and sustainability.
- *Institutional research* – research to establish clear and effective policies to minimize conflicts between water providers and users, also to establish a clear definition of rights to water and cost recovery.
- The agencies need to re-evaluate projected future water demands, and meet those demands by investing in cost-effective, aggressive water conservation programs.

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1. INTRODUCTION

The World Health Organisation (WHO), the World Bank (WB) and the Commission on Sustainable Development (CSD) have untaken several studies to confirm that substantial benefits can be derived by raising the basic level of water services standards in developing countries (SIWI, 2005). The Millennium Development Goals (MDGs) established the central role of water in sustainable development, economic growth and alleviation of poverty. Goal 7 of the MDG – Sustainable Environmental Development, which includes Target 10, is by 2015 to halve the population without sustainable access to improved water source and access to improved basic sanitation (safe drinking water and sanitation) (ibid). South Africa, like other developing countries, has committed to achieving the MDGs to ensure safe drinking water and sanitation. South Africa has not only achieved MDG but has gone further by ensuring through legislation that all citizens have access to a free basic service. Basic water is defined as 25 litres per capita per day of safe drinking water delivered within 200 metres of a household, at a minimum flow rate of 10 litres per minute. In additional each household is entitled to 6kl of safe drinking water per month.

South Africa is a water-scarce country. The current water requirements are equivalent to about 60 percent of the maximum available yield in the country in which, by far the greatest proportion (60 percent) is used by agriculture, while only 11 percent and 8 percentage required by urban and industrial use, respectively. Advance modelling has shown that the total water requirement will exceed the maximum yield by the year 2030. Under the current water pattern, the cost of water will also increase as larger schemes are required to transfer available water to the urban centres, where the greatest growth in demand is likely to occur. With this in mind the question to be asked is whether raising the basic level of water services is affordable and sustainable. A cost benefit analysis was undertaken by the Department of Water Affairs (DWA) which reports that the benefit-cost ratio for moving from an unsafe water supply facility to a low pressure restricted yard standpipe at 6000l/household/month, is 43.9.

This finding supports the view of the South African government that water is a key driver of sustainable growth and poverty alleviation, as well as an input to almost all production, in agriculture, industry, energy, transport, by healthy people in healthy ecosystems. However, the government is equally committed to improving the current level of water service by introducing the concept of improving the water services from communal standpipes to yard connections to household connections. This approach was introduced by the then Minister of Water Affairs, Mr Ronnie Kasrils. Accordingly, the Department of Water Affairs has developed a policy which is known as “moving up the water ladder” policy; this embodies raising the basic level of water services. The costs and benefits associated with “climbing up the water ladder” are determined in the Department of Water Affairs, 2008 study, The Higher Levels of Service Study.

This research study is informed by the DWA study but extends to soft implications such as: environmental, financial, human and institutional effects of raising level of basic water services including sanitation services.

1.1. Aims and Objectives of the Study

The main objective of this Study is to provide a model illustrating the potential implications and impacts of raising the basic level of water services. The Study provides an overview of population growth trend and water supply and demand in South Africa. Furthermore, the descriptive overview of scenarios of raising the basic level of water services as well as cost-benefits of water improvement is analysed. The implications of key water policies and strategies and other relevant water legislation are identified. A brief overview of the water supply sector in South Africa focuses on the natural resource management as well as on the social benefits and environmental, technical, financial, human and institutional implications of raising the level of water services. .

The aims of the project are as follows:

- Assess and quantify the implications related to raising the basic level of water services.
- Identify the potential opportunities, problems and challenges arising with water improvement projects.
- Identify alternative strategies to raising the basic level of water services.
- Develop a financial model on raising the basic level of water services.
- Recommend the best practice in terms of addressing both service level scenarios simultaneously.
- Identify further research needs.

The scope of the Report does not include an analysis of the implications of increasing the level of water services on the South African water resource.

1.2. Approach to the Study

A mixed qualitative and quantitative methodological approach, based on data sourced from strategic documents from South African National Department of Water Affairs, such as: Integrated Development Plans (IDPs); review of literature regarding water and sanitation improvement; Statistics South Africa (Census, 2001 and Community Survey 2007); case study, interviews and discussions with engineers and water and sanitation managers were used to gather information throughout the study.

In order to realise the project aims the following approach to the study was adopted:

- Search of literature, water policy review and baseline data for raising the basic level of water services.
- Identification of potential implications of raising the basic level of water services.
- Identification of the likely opportunities and constraints of raising the basic level of service.
- Development of a model for raising the basic level of the services.
- Analysis and interpretation of a case study data as well as test of the model.
- Identification of alternate strategies of moving people up the service ladder while at the same time addressing the water service backlog; and

- o Presentation of the findings of the research in report and recommendations of national implications of the study.

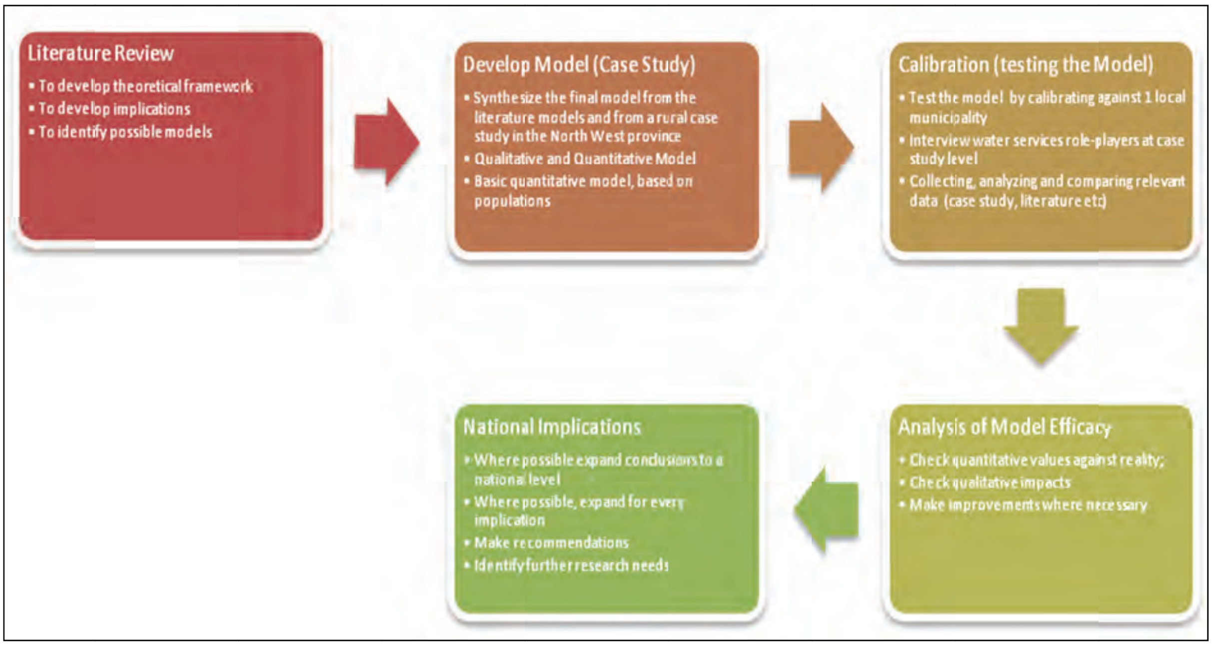


Figure 1 Graphical Methodology of the Study

1.3. Assumptions and Limitations

Developing a model for raising the basic level of water services and its potential implications and impacts is challenging due to water balance and population growth trend as well as differing resources of South African local municipalities. The following assumptions and limitations have been identified, which affect the outcomes of the study:

- o The research is a desktop and case study aimed at determining the financial, technical and environmental, institutional and human implications as well as social benefits of raising the basic level of services.
- o The study will be informed by work done in the sector on raising the free basic allowance and cost-benefits for raising the basic level of water services.
- o Raising the basic level of service refers to raising the volume of basic water and the minimum level of service such as from a standpipe to a yard connection and improving water services quality from low pressure to high pressure.
- o The model developed in the study uses one municipality as a baseline case study and the results of this modelling are then extended to a national level. This national extrapolation makes the assumption that the case study municipality conditions are representative of the national condition.
- o The study is limited to domestic or household water demand services; thus industrial, commercial and agricultural variables are not within the scope of this research.

- Incomplete demographic statistics, which would require that a comprehensive, national demographic survey be done. Available statistics are generally viewed to be unreliable as the actual household figures are often significantly higher. Therefore, multiple sources will need to be investigated to improve accuracy.
- Measurement issues such as the integrity of data, which is as important as the set of equations used in determining final outcomes.
- Significant lack of information on the current status of basic water supply and level of service data as well as network pressures in the rural areas.
- Lack of meter testing and replacement programmes. Although water meter equipment is available and water meter readings are taken, there is no structured approach to data gathering and the meter equipment is often vandalized or poorly maintained.

2. LITERATURE REVIEW OF RAISING THE BASIC LEVEL OF WATER SERVICES

2.1. Introduction

This section discusses the key concepts related to the study. First, the section defines the key concepts which determine the project scope including: water services, basic water and sanitation as well as free basic water and sanitation; secondly, it gives a brief overview of legislative framework of water and sanitation in South Africa. These are important to understand the current level of services in South African and legal requirements which are imperative for raising the basic level of water services.

2.2. Definitions of the Key Concepts

2.2.1. Water Services

According to South African Local Municipality Association SALGA (2003: 8) the term "water services" means water supply and/or sanitation services or any part thereof which is provided to domestic consumers, institutions, businesses and industries. "Water services" refers to water supply and sanitation services and includes regional water schemes, local water schemes, on-site sanitation and the collection and treatment of wastewater. Water services are essential for health and life as well as for businesses and industries. However, efficient provision of water can promote economic development growth and eradicate poverty.

2.2.2. Basic Water and Sanitation

a. Basic Water

"Basic water" is defined as a given quantity of potable water delivered within 200 metres of a household, at a minimum flow rate of 10 litres per minute. These requirements are designed to strike a balance between reducing the time and effort people have to spend collecting water, whilst still recognizing that shorter walking distances and high flow rates have cost implications (DWA, 2002). The quantity of water forming the basic minimum standard is defined as being either 25 litres per person per day based on 8 people per household or 6 000 litres per month.

The minimum standard for basic water services in terms of the Guidelines for Compulsory National Standards Regulations under section 9 of the Water Services Act (Act 108 of 1997) is:

- The provision of appropriate education in respect of effective water use; and
- A minimum quantity of potable water of 25 litres per person per day or 6 kilolitres per household per month;

- At a minimum flow rate of not less than 10 litres per minute;
- Within 200 metres of a household; and
- With effectiveness such that no consumer is without a supply for more than seven full day in any year.

b. Basic Sanitation

The minimum standards for basic sanitation service are:

- The provision of appropriate health hygiene education; and
- A toilet which is safe, reliable, environmentally sound, well ventilated, provides privacy and protection against weather, keeps odour to a minimum and prevents entry and exit of flies and other disease-carrying pests.

In developing strategies to address the water and sanitation backlogs, the Ditsobotla Local Municipality considered the above minimum requirements which in turn informed project proposals.

2.2.3. Free Basic Water and Sanitation

"Free Basic Water" is defined as the provision of appropriate education in respect of effective water use as well as a minimum quantity of 25 litres of potable water per person per day (or 6,000 litres per household per month) within 200 metres of a household, which is not interrupted for more than seven days in any year; and with a minimum flow of 10 litres per minute in the case of communal water points (DWA, 2002). Water that is used over and above the free supply must be paid for at normal municipal tariffs. Those who use more than this volume of free water must be responsible for the costs.

"Free Basic Sanitation", as defined in the policy document, consists of a basic sanitation facility which is safe, reliable, private, protected from the weather, ventilated, keeps odour to the minimum, is easy to keep clean and minimises the risk of the spread of sanitation related diseases by facilitating the appropriate control of disease carrying flies and pests, and enables safe and appropriate treatment and/or removal of human waste and black or grey water in an environmentally sound manner (DWAF, 2008).

2.3. Legal Framework for Water Services in South Africa

The South African government has established various pieces of legislation regarding the water and sanitation use and management. A strong political will was demonstrated to implement sustainable water development through sound water governance. This led to reforms in water policies and institutions. Some of the foundational policies are summarised below:

- *Water Service Policy, (White Paper) 1994 – a*ddresses the backlogs in the country's water service and the institutions and mechanisms needed to remedy the backlogs.

- *Republic of South Africa Constitution (Act 108 0f 1996)* – establishes a human right dimension for access to adequate and sustainable water supply and services and enshrines the Bill of Right.
- *Water Service Act (WSA) of 1997 (act 108 of 1997)* – ensures the right of access to basic water supply and sanitation, and also provides a regulatory framework and establishment of water services institutions such as water boards, water services providers, etc. It creates a comprehensive legislative framework for the provision of water supply and sanitation services to support life and personal hygiene and recognises the need to operate in a manner consistent with the broader goals of water resources management. It encourages cooperative governance with emphasis on capacity building at all levels. It spells out the role of DWAF in the event of non-performance by provincial and local governments.
- *National Water Policy of 1997 (DWAF 1997)* – redefined ownership and allocation of water. It declares that all water irrespective of where it occurs in the hydrological cycle is public water, and that the national government will act as a public trustee.
- *National Water Act of 1998 (Act 36 0f 1998)* – Founded on 2 pillars: sustainability and equity, it amongst other things required the establishment of a National Water Resource Strategy (NWRS) to set out a national framework for managing water resources.
- *National Water Resource Strategy (DWAF, 2004)* – provides the national implementation framework and divides the country into 19 water Management Areas (WMA).
- *The National Water and Sanitation Program* – an international partnership aimed at enhancing accessibility to safe and affordable water supply and sanitation for the poor.
- *The Local Government: Municipal Structures Act, 1998* – provides a legal structure for defining and implementing a post-transitional system of local government and defines types and structures of municipalities including: Category A (Metropolitan), Category B (Local), Category C (District).
- *The Local Government: Municipal Systems Act, 2000* – determines how local government should function and allows for various types of partnership arrangements a municipality may enter into to ensure delivery of services for example water.
- *The Local Government: Municipal Structures Amendment Act, 2000* – establishes the function of ensuring access to water services at a district level, unless a local municipality is authorised to perform this function.

2.4. Policies and Strategies Perspectives for Water Services in South Africa

The Water Policy and Strategies in South Africa are based upon the principles of equity, sustainability and efficiency. The resource protection approach supports the sustainable use of water resources in a water-scarce environment; while the efficiency and equity considerations of water allocation and pricing systems are required to manage a scarce resource, while taking account of past discrimination and its effects on access to water (Eberhardt and Pegram 2000). The intended institutional arrangements should facilitate the useful and reliable management of water services and resources in South Africa, balancing the strategic national interest with local needs and desires (ibid).However, the available resources and methods of providing services as contained in the Water Act will determine the degree of its success in achieving efficient and sustainable water systems in South Africa.

The South African water supply sector, which has been characterised by immense challenges, can pride itself today as a leader in water supply development in Africa, based upon government determination to deal with those challenges and formally recognising water as a human right. South Africa has made significant changes in water policies and strategies; among them – the Strategic Framework for Water Services (2003) provides overarching policy direction by stating that "Every Water Service Authority (WSA) has a duty to ensure that at least a basic water supply and sanitation service is provided to every household within its jurisdiction. This universal service obligation is subject to availability of resources and to the progressive realisation of rights contemplated in the Constitution". The 1995 White Paper on Community Water Supply and Sanitation also provided a policy statement that is still relevant to the implementation of Free Basic Water: "Some for All, and not All for Some".

Furthermore, the implementation of Free Basic Water (FBW) must be consistent with the overarching water supply services policy, and the Municipal Indigent Policy, both of which promote: provision of services progressively – providing basic infrastructure to ensure access, operating water supply services efficiently (financial and operational viability) and then providing basic water to the poor in an effective (i.e. ensuring more poor people are included, and that those that can afford to pay do pay) sustainable (considerate of institutional and resource capacity) and financially viable manner (able to recover the actual cost of provision) and addressing service provision by using approaches that are considerate to the needs of the poor and – ensuring that the poor benefit more from pro-poor policies (DWA, 2003).

In terms of policy on volume of water by municipalities, the following must be taken into consideration:

- The FBW policy concerns water for basic domestic use to achieve acceptable health and hygiene.
  - The six kilolitre limited amount excludes water for flushing, which should be provided as part of Free Basic Sanitation where water-borne systems are used
  - Productive water use is not covered by the basic amount. WSAs should consider their local circumstances and decide whether there is merit in increasing the basic amount to cover this use
- Where the chosen targeting mechanism requires registration of households, the description of household must be consistent with the description of a consumer unit.
- A WSA should further consider additional circumstances that may trigger an increase of the free basic water amount; however, financial viability remains a key determinant.

The FBW policy was introduced by the South African government to ensure that all households have access to a basic water supply; it ensures that every household receives 6 000 litres of free water per month. This means that households are not charged for the first 6 000 litres of water they consume each month, although consumption over and above this volume is chargeable. The provision of a free basic supply of water is primarily aimed at improving the quality of life of those South Africans who cannot afford to pay for water. Free Basic Water is a National Government policy that can be implemented only by local government, which is constitutionally responsible for the provision of basic services. However, to ensure the success of this policy, National Government and the South African Local Government Association are responsible for providing direct assistance to local authorities. The capacity of government to provide services effectively is a critical constraint in many areas in South Africa. Emphasis on helping local government to develop the necessary capacity to ensure effective delivery is required. In this respect, the private sector has an important role to play, but in all cases, the public interest is promoted and protected.

The legal framework for implementation of Free Basic Water is essentially that of tariff setting which is guided by the Constitution of the Republic of South Africa (Act No 108 of 1996), the Local Government: Municipal Systems Act (Act no. 32 of 2000) and the Water Services Act (Act No. 108 of 1997). The relevant clauses of these Acts are briefly outlined – The Constitution states in section 152 that one of the objectives of local government is "*to ensure the provision of services in a sustainable manner*". The Municipal Systems Act in section 74 states that: *"A municipal council must adopt and implement a tariff policy on the levying of fees for municipal services provided by the municipality itself or by way of service delivery agreements, and which complies with….any other applicable legislation*".

The Municipal Systems Act (MSA) in section 75 states that: "A municipal council must adopt by-laws to give effect to the implementation and enforcement of its tariff policy". The Water Services Act determines in section 10(1) that: "The Minister may, with the concurrence of the Minister of Finance, from time to time prescribe norms and standards in respect of tariffs for water services" and following that in section 10(4) stipulates that: "No Water Services Institution may use a tariff which is substantially different from any prescribed norms and standards". Such norms and standards for tariffs have been promulgated by the Minister of Water Affairs and Forestry. In this Regulation 3(2) a water services institution must consider the right of access to basic water supply and the right of access to basic sanitation when determining which water services tariffs are to be subsidised.

The Water Services Act (WSA)Section 4(3)(c) states that procedures for limitation or discontinuation of water supply services must not result in a person being denied access to basic water supply services for non-payment, where that person proves, to the satisfaction of the relevant water services authority, that he or she is unable to pay for basic services. The Water Services Act (Act 108 of 1997) and the National Water Act (Act 36 of 1998) control water services in South Africa, with the former dealing specifically with water service provision to consumers. Central to the supply of water to a community is the Water Services Development Plan (WSDP) of the relevant Water Services Authority on a Provincial level. The WSDP defines the minimum level of water service for communities, as well as the desired level, in adherence to a Water Services Provider in the relevant area of jurisdiction. The WSDP further describes both present and future arrangements that need to be made for water service provisions in an area (CSIR, 2003). There are many social and organisational constraints associated with the provision of potable water that need to be addressed in the objectives of any water supply project, bearing in mind the principles of sustainability, affordability, efficiency and appropriateness.

3. POPULATION GROWTH TRENDS AND WATER SUPPLY AND DEMAND IN SOUTH AFRICA

3.1. Introduction

This main aim of this study is to develop a model for raising the basic level of water services. However, any water and sanitation projects in a country such as South African, characterized by water scarcity and high level of population and industrial growth, need to take account of water availability and population growth trend for water sustainable systems. Consequently, this section gives general trends of population growth and water resource availability and demand.

In South Africa, the agriculture sector is the largest water user, with a demand of more than 60 % of total water use. Therefore, efficient use of water in this sector has the potential to increase water availability significantly, not only for the agriculture sector, but also for other sectors such as domestic, commercial, and industrial.

3.2. Water Demand and Supply in South Africa

According to Eberhardt and Pegram (2000), South Africa's water resources may be characterised as follows:

- a water scarce country;
- water resources are not spread evenly across the country;
- country suffers from hydrological extremes;
- areas of mineral wealth and economic development are not coincident with run-off; groundwater is not abundant;
- in several river catchments the water requirements far exceed the natural availability of water,
- overall, the available water resources are insufficient to meet projected demands at current usage and price levels within the next 30 years or so; and
- water development costs have been rising in real terms in recent years.

The most recent and reliable data on water resource availability and use in South Africa is presented in DWAF 1986 and 1997. According to DWAF (1997: 51), the total surface water run-off of South Africa is estimated to be 50 150 million m^3 per annum; of this 20 350 million m3 (41%) was already utilised in 1996; a further 13 250 million m^3 (26%) could be available for future use; the remaining 33% is not usable from a practical and economic perspective.

The per capita volume of available water resources is an important indicator of environmental services and the ability of a country to support the needs of the population; an average supply of acceptable quality freshwater is not only a basic human right, but vital to life(DWAF, 1997). The United Nations has set a target of 1 000 m^3per person per year to satisfy a country's water needs (Scholes and Biggs, 2004). South Africa is a water-stressed country, ranked as one of the 20 most water scarce countries in the world, with an annual precipitation in the region of 500 mm per year. This value is low compared to the world average of 860 mm per year (ibid). The availability of water in 2001 was estimated at 1 156 m^3/capita/year (ibid). This value is marginally higher than the minimum value of 1 000 m^3/capita/year as suggested by the United Nations. Scholes and Biggs (2004) have predicted the water availability in South Africa in 2001 and 2030 which is provided in Table 1 below.

Table 1: Estimated population and water availability (m^3/capita) in South Africa in 2001 and 2030

Estimated population size in 2001 (million)	Water availability in 2001 (m^3/ capita)	Estimated population size in 2030 (million)	Water availability in 2030 (m^3/ capita)
43.2	1 156	42.2	1 186

Source: Scholes and Biggs, 2004

As indicated by Scholes and Biggs (2004) the average rainfall in South Africa is 450 mm per year; this value is less than half of the world's average rainfall, adding up to a potential supply of approximately 1 100 m^3per capita per year; this includes rivers, dams, lakes, wetlands, aquifers and inland water resources. There are currently nineteen Water Management Areas in South Africa, encompassing 320 major dams with a total capacity of 32 400 million m^3 (ibid).

3.3. Water Use and Water Demand Projections in South Africa

The estimation of water use and water demand in South Africa is discussed and presented by DWAF (1986 and 1997).These are summarised in Tables 2 and 3 below. A time-series for each of the two separate data sources (DWAF, 1986 and 1997) is calculated from the implied annual compound growth rates and presented in Table 3 below.

Table 2: Water use estimation for South Africa

Sector	1980	1990	1996	2000	2010	2030
Urban and domestic	1 500	2 280	2 170	3 220	4 480	6 940
Mining and industrial	1 780	2 400	1 600	3 400	4 510	3 380
Irrigation and afforestation	10 100	11 410	12 340	12 860	13 940	15 870
Environmental	2 950	2 950	3 930	2 950	2 960	4 230
Total	16 300	19 050	20 050	22 440	25 890	30 420

Source: DWAF (1986 and 1997).

Table 3: Water use growth rates (% per annum)

Sector	80-90	90-00	00-10	97-30
Urban and domestic	4.2	3.5	3.4	3.6
Mining and industrial	3.1	3.5	2.9	2.3
Irrigation and afforestation	1.3	1.2	0.8	0.8
Environmental	0.0	0.0	0.0	0.2
Total	1.6	1.7	1.4	1.3

Source: DWAF (1986 and 1997).

Table 4 below summarises the possible water balance in 2030 which estimates the current and future water balances in South Africa by region. The comment is as follows: "*It is evident that virtually all the available resources will have been transferred for use in the major urban/ industrial centres. The water which appears to be available in the eastern part of the country [that is, the eastern inland region] is actually allocated to be shared with Swaziland and Mozambique. The other segment along the southern and south-eastern coast represents water of poor quality and from small coastal rivers where it is doubtful whether the use of these resources will be practically and economically feasible. Also to be inferred from the [data] is the recognition of the potential disastrous consequences facing the country should serious changes not be made, as well as the importance and urgency of the timeous introduction of appropriate strategic measures to prevent the stagnation of South Africa's development due to a lack of sufficient water, a few decades from now? The same picture with regard to the full utilisation of water will emerge, irrespective of where the development is to take place or whether industries are to relocate to the better watered areas, as the overall water requirements will not be materially changed as a result thereof..*". However, the estimated water requirements projections are highly uncertain, as already indicated above (DWAF, 1997: 63).

The water balance is an important step in the process of raising the basic level of water services. With total water demand known multiplied by typical consumption patterns for each level of services, the annual water demand and wastewater flow and load projections can be addressed.

Table 4: Potential water balance in 2030 (DWAF, 1997b: 63)

Region	Maximum yield million m^3 pa	Water requirements million m^3 pa	Net transfer million m^3 pa	Surplus million m^3 pa
Northern	2 566	5562	3 014	18
Eastern inland	4 834	3 168	-500	1 166
Eastern coastal	13 199	8 860	-2 580	1 759
Southern coastal	1 793	2 442	750	101
South western	3 095	3 884	70	-719
Karoo	6 014	2 669	-2 821	524
Central	1 789	3 830	2 067	26
South Africa (Incl. Lesotho and Swaziland)	33 290	30 415	-	2 875

Source: DWAF, 1997b:

Household density and service level at National Level as compared by Ceenex (2008) has shown that settlement density expressed as number of households per hectare is a vital cost driver for the water infrastructure. The key issue then becomes how much it will cost to upgrade the 3.6 million households that do not have adequate water service level, plus those that currently only have access to a communal stand pipe (ibid).

- Table 5 below confirms that the majority of the households are urban and as such can be considered high density (2500 hh/ha), amounting to 52% whilst the second largest grouping lives in rural villages (>500 hh/ha), comprising 16% of the total.

- An unacceptably large number of households still do not enjoy an adequate water service level. Almost 28% of all households, numbering 3.6 million households do not have a yard water connection.
- Of the 3.6 million households without a yard connection 1.3 million households still do not have even access to a suitable communal stand pipe.
- Of the 28% almost 10% lives in high density urban areas, whilst another 9% live in rural villages.
- Less than one percent of the "household have nots" live on farm land (ibid).

Table 5: Household density compared to Service Level at National Level

Density Type vs. Service Level						
	Farmland	**Rural Scattered**	**Rural Village**	**Rural dense**	**Urban**	**Total**
Not Adequate	21 454	227 024	455 571	199 962	418 963	1 322 973
Communal S/P	60 783	351 740	707 595	292 263	855 338	2 267 718
Yard S/P	108 861	168 718	369 218	250 512	3 039 911	3 937 220
House connect	149 732	240 384	521 410	350 813	4 236 302	5 498 641
Total	340 830	987 865	2 053 794	1 093 550	8 550 513	13 026 552
HH to yard upgrade	82 236	578 764	1 163 166	492 225	1 274 301	3 590 691
% have not	0.6%	4.4%	8.9%	3.8%	9.8%	27.6%

Source: Ceenex, 2008

Wagner and Manus (2008) note that the main driver of the cost is density and the cost of reticulation. The model included costing for the entire water services system chain which comprises raw water storage, purification, other bulk and network infrastructure and resources required to invest, operate and maintain the system. Other salient features of the South African water system are presented in Table 6 below, indicating the water and sanitation backlog as well as estimated cost to eradicate the backlogs dated January 2005from a local government perspective. It is interesting to note that based on 2007 public sector data, the water services budget amounted to only 1.3% of the South African GDP (ibid).

Table 6: Local Government Perspective

Province	Population	Households	Water Below RDP Pop.	Unit Cost Water Per Capita	Total Cost Water
Eastern Cape	6 485 501	1 586 132	2 183 123	R1 486.94	R3 778 839 256
Free State	3 093 252	769 922	334 408	R856.62	R281 516 150
Gauteng	10 281 016	2 284 671	2 064 244	R1 301.15	R2 795 472 487
KwaZulu-Natal	9 652 626	2 085 344	3 340 809	R1 841.71	R6 506 755 042
Limpopo	6 535 450	1 293 701	2 341 779	R1 805.92	R4 687 052 291
Mpumalanga	4 297 205	1 040 167	733 974	R1 200.00	R880 768 574
North West	5 084 595	1 157 880	787 211	R1 276.46	R1 083 495 650
Northern Cape	926 721	259 001	74 081	R1 897.39	R135 439 000
Western Cape	4 837 876	1 231 954	379 699	R1 166.27	R797 304 177
National Total	51 194 242	11 708 772	12 239 328	R1 416.69	R20 946 642 627

Source: Wagner and Manus, 2008.

Table 7 below presents the water services level for each province in respect of the HLOS impact per province in 2008. The Eastern Cape shows a 50% service backlog, followed by Limpopo Province with47%. Both also have currently the highest number of households without a yard connection. Western Cape (8%) and Gauteng (10%) have achieved the highest level of backlog reduction. KwaZulu-Natal with 971 000 households and Eastern Cape with 795 000 households have the highest backlog numbers. The Northern Cape (53 000) and Western Cape (113 000) has the lowest number of service level backlogs. The KwaZulu-Natal, Eastern Cape and Limpopo provinces collectively have 66% of the country's water services backlog, whilst containing only 40% of the total number of households. A case can be made to implement the policy initially in one or more of these provinces.

Table 7: Household density compared to Service Level at Provincial Level

Provincial Service Level Impact Summary							
Province	**Not Adequate**	**Communal S/P**	**Yard S/P**	**House connect**	**TOTAL**	**Backlog**	**% backlog**
Eastern Cape	250 362	544 304	332 841	473 677	1 601 184	794 666	50%
Free State	11 288	133 563	272 011	379 017	1 44 851	1 44 851	18%
Gauteng	109 575	244 851	1 268 036	1 764 988	354 426	354 426	10%
KwaZulu-Natal	442 176	528 915	619 524	863 991	971 091	971 091	40%
Limpopo	250 045	337 648	279 722	392 328	587 693	587 693	47%
Mpumalanga	108 613	159 989	265 434	370 347	2 68 602	2 68 602	30%
North West	97 809	205 600	259 827	362 581	3 03 409	3 03 409	33%
Northern Cape	19 248	3 3 744	8 8 694	123 679	52 992	52 992	20%
Western Cape	33 857	7 9 104	551 131	768 033	112 961	112 961	8%
TOTAL	1 322 973	2 267 718	3 937 220	5 498 641	13 026 552	3 590 691	28%

Source: Ceenex, 2008

Table 8 below presents the estimated annual capital expenditure (capex) and operating expenditure (opex) for each province and for the selected density types as indicated in the Ceenex 2008 report as well as comparing the capital expenditure required for each density type to deliver at a yard connection services level. As far as capital expenditure at a provincial level is concerned, the provinces with the worst backlog numbers should also be those that require the biggest portion of the capex required (ibid).

Accordingly it can be noted that Eastern Cape (R11.3 billion), KwaZulu-Natal (R13.0 billion) and Limpopo (R10.6 billion) require the biggest stake of the money. About 66% of the investment required is allocated to these three provinces, while KwaZulu-Natal (R890 m, Eastern Cape (R884 m) and Limpopo (R735 m) are the provinces that will have the highest OPEX. The Northern Cape (1%), Western Cape (3%) and Free State require the lowest amount of capital while Northern Cape (R44 m) Western Cape (R64 m) and Free State R162 m) will have the lowest operating costs should the policy be implemented. For implementation purposes, at a Provincial level, decision makers will have to decide how the implementation framework will be done. As mentioned in the HLOS1 Report the cost effect of low density housing is significant. While the number of backlog households in the rural village and urban density groups is almost the same, the operating cost of the rural village is three times more than that of the urban sector. A third of the backlog households will require half of the budget for opex.

Table 8: Provincial Costs: CAPEX and OPEX (annual)

Province	Farmland	Rural Scattered	Rural Village	Rural dense	Urban	TOTAL CAPEX/ OPEX to upgrade to Yard standpipe	%
Provincial Costs: CAPEX (annual)							
Eastern Cape	R49 m	R1 591 m	R7 980 m	R200 m	R1 490 m	R11 309 m	21%
Free State	R799 m	R6 282	R102 m	R80 m	R1 420 m	R2 401 m	5%
Gauteng	R331 m	R0	R3 m	R121 m	R4 204 m	R4 659 m	9%
KwaZulu-Natal	R0	R1 701 m	R6 471 m	R1 316 m	R3 532 m	R13 020 m	25%
Limpopo	R1 188 m	R119 m	R5 820 m	R2 569 m	R916 m	R10 612 m	20%
Mpumalanga	R659 m	R21 m	R615 m	R1 375 m	R1 584 m	R4 254 m	8%
North West	R77 m	R93 m	R1 643 m	R1 799 m	R1 060 m	R4 671 m	9%
Northern Cape	R62 m	R87 m	R145 m	R65 m	R323 m	R682 m	1%
Western Cape	R80 m	R25 m	R5 m	R8 m	R1 321 m	R1 439 m	3%
TOTAL	R3 245 m	R3 636 m	R22 785 m	R7 532 m	R15 850 m	R53 047 m	100%
%	6%	7%	43%	14%	30%	100%	
Provincial Costs: OPEX (annual)							
Eastern Cape	R6 m	R194 m	R620 m	R7 m	R57 m	R884 m	25%
Free State	R98 m	R768	R8 m	R3 m	R54 m	R162 m	5%
Gauteng	R40 m	R0	R241 848	R4 m	R160 m	R204 m	6%
KwaZulu-Natal	R0	R208 m	R503 m	R45 m	R134 m	R890 m	26%
Limpopo	R145 m	R15 m	R452 m	R88 m	R35 m	R735 m	21%
Mpumalanga	R81 m	R3 m	R48 m	R47 m	R60 m	R238 m	7%
North West	R9 m	R11 m	R128 m	R61 m	R40 m	R250 m	7%
Northern Cape	R8 m	R11 m	R11 m	R2 m	R12 m	R44 m	1%
Western Cape	R10 m	R3 m	R415 834	R270 009	R50 m	R64 m	2%
TOTAL	R397 m	R445 m	R1 772 m	R257 m	R602 m	R3 471 m	100%
%	11%	13%	51%	7%	17%	100%	

Source: Ceenex, 2008

3.4. Multiple Uses Water and Raising the Basic Level of Water Service

Poor populations need water for domestic uses, ranging from drinking, hygiene and sanitation to food production and income generation. Existing approaches to water service delivery typically entail systems that are designed, managed and financed for a single use, for example, drinking. But the people often rely on such single-use systems to meet multiple water needs, needs not considered in the planning or management of the system. An alternative model for water service provision, known as multiple-use approaches to water service delivery, is a consumer-oriented approach that takes people's multiple water needs as a starting point and involves planning, finance and management of integrated water services for multiple domestic and productive uses (Renwick, et. al, 2007).

Communities use water for an array of domestic and productive uses, including drinking, cooking, cleaning, bathing, laundry, sanitation, livestock, crop irrigation, horticulture, tree growing, fuel wood and fodder production, fisheries, pottery, brick making, small-scale food processing and butchery, and for other water-dependent enterprises and ceremonies. All these uses are vital for their wellbeing. To meet these needs, they often draw upon multiple sources of water (van Koppen et al., 2009). Professionals became aware of this gap, because they began to observe that systems designed for single water use were used for multiple purposes in an unplanned way, and so became *de facto* multiple-use systems. 'Irrigation' systems are used for drinking, bathing, washing, cattle watering, small enterprises, fisheries, or irrigation (Renwick, et. al, 2007). Systems planned for drinking water and other domestic uses are used for cattle watering, irrigation and a range of other small-scale productive uses (ibid). While some unplanned uses were absorbed by the system, others caused damage to infrastructure or deregulated planned water allocation schedules. However, measures to prevent unplanned uses, e.g. by forbidding and declaring those uses as 'illegal', were ineffective (van Koppen et al., 2009).

Armed with this new understanding, the sub-sectors started proactively enhancing accessibility to water with the double aim of stimulating the livelihood benefits and avoiding damage and disturbance to the systems. They adapted their designs with 'add-ons'. Irrigation designers constructed washing steps or cattle entry points in irrigation canals. To encourage fisheries and other aquaculture, connectivity was improved and dead storage guaranteed in reservoirs, streams and even at field level for crop-fish systems, where a crop such as rice can be grown and fin fish or prawns farmed in the same field (ibid). Domestic systems were equipped with cattle troughs, washing slabs, and sometimes a communal garden. In these ways, for limited extra cost, the uses and corresponding livelihood benefits were augmented. Water services that maintain the primary objective of their own sector, but accommodate uses beyond the sector's mandate, 'irrigation-plus' or 'domestic-plus' water services (van Koppen et al., 2009). A question needs to be asked when raising the basic level of water services whether our water resources can afford to supply the increase in the demand and what implications this may entail.

4. SCENARIOS AND IMPLICATIONS FOR RAISING THE BASIC LEVEL OF WATER SERVICES IN SOUTH AFRICA

4.1. Introduction

This section is the core of the study since it encompasses the key concepts and discussions around the issues of developing a model for raising the basic level of water services in South Africa. This section discusses potential scenarios for “climbing the ladder” for water services by determining the service options. Such a section is vital for this study because it determines the potential options for raising the basic level of water services in South Africa and what each option requires in term of cost-benefits. Of course, raising the basic level of water services is a process which has several implications thus this section outlines and analyses the implications which occur with the improvement of water services such as financial, human, institutional, environmental, water quality and quantity and so on as well as the expected benefits of the improvement.

4.2. Options and Scenarios for Raising the Basic Level of Water Services

There is a range of water supply service options which are either below or above RDP level. The options which commonly fall below the minimum "RDP level" are unimproved traditional sources, tanker systems, private water cartage and vending, unprotected wells and unprotected springs. Only those levels that are at or above the minimum “RDP level” are discussed here including: house connection, yard connection and standpipe.

4.2.1. Communal Standpipes

Generally available in the rural and low income areas, a communal standpipe is a single standpipe shared by a number of households. The number of households per standpipe will depend on the density of dwellings in the settlement. A ratio of 25 households per tap is typical in an urban dense settlement; however it should be noted that in a sparse rural settlement pattern this would often result in substantially exceeding the maximum desirable 200 m walking distance to the nearest standpipe. In these cases a median ratio of 7 to 12 families per standpipe is more realistic. It is recommended that the ratio decided upon needs to be motivated in terms of the settlement pattern. Where the ratio is higher, the possibility of consumers having to queue must be considered and several taps per standpipe may be more efficient.

4.2.2. Yard Tap and Yard Tank Connections

For this option, a single tap is provided on each plot, either as part of a private standpipe or mounted on the wall of a toilet, if a water-borne sanitation system is used. Although this has not always been done in the past, it is essential that a meter be provided. Yard taps can be used with dry sanitation systems, LOFLOS or water-borne systems. If a water-borne system is not used, drainage of wastewater at the yard tap needs to be considered. This could be a connection to the roadside drain, or through the installation of a soak-away. If customers are paying for water, this becomes less of a problem as there is less wasted water. The yard tank is an option in which a tank is installed in the household yard. This can be filled every day from a central point by a tanker truck or by a drip feed arrangement controlled, for by a suitable valve. In most cases the volume of the yard tank is limited to 200 litres, although the yard tank capacity can range from around 170 litres to 5 000 litres. It is possible for more than one tank to be provided per customer. It may also be feasible for tanks to be mounted above ground to allow water to be piped into the house.

4.2.3. House Connections

This option provides a metered, and typically unlimited, supply to the plot, with a connection to the house and several taps in the house. It requires a wastewater system, such as a septic tank or connection to a waterborne sewerage system, to handle the grey and waste water flows.

Water consumption per household will exceed that of the first two supply options, and thus the meter and the proven ability to pay for the water used are essential pre-conditions for the installation of this level of service.

4.2.4. Analysis of Supply Options and Scenarios Used in the Model

Each option presents the advantages and disadvantages; once these are known, a choice can then be made as to which option may be useful in areas according to the population density and income level.

Table 9 below shows the range of service level options and some of their advantages and disadvantages.

Table 9: Advantages and Disadvantages of Water Service Options

Service Level	Service Option	General comment	Advantages	Disadvantages
Level 1	Standpipe & communal taps	Average 25 households per tap, linked to settlement pattern. Standpipe can have more than one tap.	Generally least expensive. Low consumption & delivery rate (10l/min).	Customer inconvenience. Water stored open in buckets – health risk. Poor designs create water pooling which creates an environment & health risk. Reduced cost recovery options. Water wastage.

Service Level	Service Option	General comment	Advantages	Disadvantages
Level 2	Yard tap connections	Metered. Not connected to any private plumbing fixtures.	Water available "on-site". Accurate meter reading and billing possible. Greater sanitation options. Less wastage.	Potentially open stored water (buckets) – health risk. Poor designs create – water pooling which create an environmental & health risk.
Level 3	House Connections	Fully metered, pressurized connection. no limitation on usage. requires proven ability to bear full cost by consumer.	Highest level of convenience for both customer and service provider. Accurate meter reading and billing.	High cost to Municipality. High levels of water usage, greater bulk infrastructure required. Difficulty to control water usage. Needs complementary wastewater system.

Source: Industry Guide to Infrastructure Service Delivery Levels and Unit Costs – 2010 (Final)

4.2.5. Cost Considerations

As indicated in Table 9 above, each option has its advantages and disadvantages. Each options also carries with it different investment costs. The Department of Water Affairs has developed a Cost Benchmark for each aspect of the various levels of service. This includes capital, operational and maintenance costs. Table 11 below shows the maintenance cost of water reticulation units in Rand for the various options of residential water supply per household density.

Table 10: Water Reticulation – Maintenance Cost per Household

Maintenance Cost per annum per household				
Element	Material	Household Density (houses per hectare)		
		5	15	40
House connection	Hard soil excavation (15% ripping; 5% blasting)	R2,241.18	R1,239.87	R787.03
	Moderate soil hardness (10% ripping)	R1,820.96	R1,007.40	R639.46
	Soft soil excavation	R1,400.74	R774.92	R491.89
Yard connection	Hard soil excavation (15% ripping; 5% blasting)	R1,470.85	R803.31	R501.41
	Moderate soil hardness (10% ripping)	R1,195.07	R652.69	R407.40
	Soft soil excavation	R919.28	R502.07	R313.38

Maintenance Cost per annum per household				
Element	**Material**	**Household Density (houses per hectare)**		
		5	**15**	**40**
Communal standpoints	Hard soil excavation (15% ripping; 5% blasting)	R490.48	R240.16	R126.95
	Mode rate soil hardness (10% ripping)	R398.52	R195.13	R103.14
	Soft soil excavation	R306.55	R150.10	R79.34

Source: DWA Cost Benchmark 2009 (basic LoS)

Table 12 below indicates the range of operation unit costs in Rand for the various options of residential water supply per household density as developed by the Department of Water Affairs on Cost Benchmark 2009 for the basic level of services.

Table 11: Water Reticulation – Operation Cost per Household

Water Reticulation – Operation cost per household			
Element	**Household Density (houses per hectare)**		
	5	**15**	**40**
House connection	R3 744.00	R3 744.00	R3 744.00
Yard connection	R1 440.00	R1 440.00	R1 440.00
Communal standpoints	R864.00	R864.00	R864.00

Source: DWA Cost Benchmark 2009 (basic LoS)

In most instances, water distribution and storage are the most costly parts of a water supply scheme. Good design in this regard is thus critical to facilitate cost reduction. Elements to take into consideration include (CSIR, 2003):

- Bulk water transmission systems;
- Bulk storage reservoirs;
- Intermediate storage reservoirs; and
- Terminal consumer installations.

The Global Water Supply and Sanitation Assessment Report (WHO and UNICEF, 2000) gives median construction costs per person served for the listed technologies for the three main regions of the developing world. However, local conditions, such as the size of the community to be served, topography and the presence of suitable aquifers, can cause tremendous variations in the unit cost of water supply. For a community of given size, there are significant returns to scale in the number of house connections made. Most of the investment in major works must be made before house connections can be offered, so that the marginal cost of each connection is only a fraction of the total. For these and other reasons, water supply is a natural monopoly requiring "lumpy" investments, which makes the unit costs difficult to calculate (Cairncross and Valdmanis, 2006).

The range of cost of house connections in Africa is generally broad, given that the reported costs of house connections relate almost exclusively to urban areas, because such connections are only rarely provided in smaller communities. Piped systems in general and house connections in particular, will tend to be more expensive per capita the smaller the size of the rural community, than in urban areas (ibid). For public water points corresponding to improved water supply, hydro-geological and other constraints mean that the cheapest technology is not feasible in every community. A cost figure of US$40 per capita is about the middle of the range offered by different technologies (standpipe, borehole, and dug well) although it can be expected to vary between US$15 and US$65 or more, depending on local conditions (Cairncross and Valdmanis, 2006). The range of costs reported by individual countries in the Global Water Supply and Sanitation Assessment 2000 Report varied by more than an order of magnitude.

In calculating the cost-effectiveness of investment in water supplies, one must amortize these capital costs over an appropriate lifetime. Most major components of an urban water supply system have a potential lifetime of 50 years or more, but a prudent utility would aim to amortize them within about 20 years. A reasonable basis for calculation, for both urban and rural supplies, is to allow an amount of 5 percent of the capital cost as an annual straight-line amortization of the construction cost of the water supply. The Global Water Supply and Sanitation Assessment Report (2000) also gives median reported production costs per cubic meter for urban (house connection) water supplies as US$0.20 for Asia and US$0.30 for Africa and Latin America and the Caribbean. If a mean daily water consumption of 100 litres per capita is assumed by those with household connections, those figures give annual per capita operation and maintenance costs of US$7.30 and US$10.95, respectively, or 8 to 10 percent of the capital cost of construction.

4.3. Resource implications of raising the basic level of water services

4.3.1. Technical Implications

Improving the basic level of water services requires reliable infrastructure. Raising the basic level of water services has implications for technology change including: infrastructure (on-site individual homestead, communal point-source systems, communal point-source systems and distribution networks) and water treatment (protecting the source, central treatment, partial treatment, and household treatment) and individual home-based technologies (shallow wells, boreholes, ponds, roof water and greywater). Each level of water services necessitates specific materials and technologies for construction, operation and maintenance to accommodate the changes.

Raising the basic level of water services is about “climbing the ladder”, not only from unimproved to improved water options but also improved basic water pressure and house connections. Moving up the ladder has two basic components, moving upwards from the perspective of an increased quantity of water or from an increased convenience level, i.e. better access to water, closer to the point of use. These two are interlinked, in that the more convenient the access, the higher the likely water volumes to be used. However, at every level of convenience, more water volume could be used if it were made available.

4.3.2. Human Resource Implications

Raising the basic level of water services requires qualified human resources such as project managers and planners, engineers, artisans and laboratory and other technical staff to design, implement and maintain the water supply systems.

The skills are generated from the country's schooling and tertiary education system. If the skills are not being generated, an expansion of the water supply system cannot be sustained.

4.3.3. Financial Implications

Raising the basic level of water services need to mobilise large amounts of money for capital and operational costs. The costs required are calculated on the basis of the number of people to whom water services need to be extended (households) and a per construction and operation, value and potential inflation. South African provinces, district municipalities and local municipalities have varying economic capacities due to their different potentialities. As indicated in Table 14 below, certain local municipalities do not have enough financial resources to afford the new pipes, the distribution costs, and water treatment costs.

Table 12: Financial Impact in 2009 Rands for Capex and Opex vs. HH Density

Density Type vs. Cost						
	Farmland	**Rural Scattered**	**Rural Village**	**Rural dense**	**Urban**	**Total**
Capex	R3 245 m	R3 636 m	R22 785 m	R7 532 m	R15 850 m	R53 047 m
Capex/bhh	39 456	6 282	19 588	15 301	12 438	14 774
Capex/thh	9 520	3 681	11 094	6 887	1 854	4 072
Opex	R397 m	R445 m	R1 772 m	R257 m	R602 m	R3 471 m
Opex/bhh/m	R402	R64	R127	R43	R39	R81
Opex/thh/m	R97	R37	R72	R20	R6	R22

Source: Ceenex, 2008

4.3.4. Institutional Implications

Improvement of the basic level of water services has direct or indirect implications on national and local water institutions' capacity for water provision. However, increasing the basic level of water services will have implications for those institutions which will be required to modify their water services. They also require management input such as economic decision-making, member selection for committees responsible for the condition of the facilities, information dissemination, and problem – solving in order to strengthen and empower the function of the water supply service.

The major institutional issues faced by the water services sector are listed in the table below.

Table 13: Institutional Implications

Sector	Implications
Water improvement	- Financial constraints. - Poor cost recovery by utility companies. - Absence of infrastructure for recycling. - Lack of awareness/knowledge/education. - Lack of awareness among politicians coupled with negative interest. - Dilapidated infrastructure coupled with declining investment and sub-economic tariff adjustments that have led to financial hardships for water utilities, etc. - Water pricing system. - Economic inequity and poverty. - Unmetered consumption. - Behavioural patterns (Attitude). - Poor management practices and lack of incentives to retain qualified personnel, which has led to duplication of effort and wastage of the available meagre resources. - Lack of / inadequate institutional and logistical capacity for effective operation and maintenance activities.

Source: Ceenex 2008

Water services improvement affects numerous institutions, which are affected either directly or indirectly by any change in the sector. These institutions and stakeholders are listed in the Table below (Ceenex, 2008).

Table 14: Directly and Indirectly Affected Institutions

Affected Sector	Directly and Indirectly Affected Institutions
Customer Groups	Businesses, Commerce, Industry, Government, Residential.
Local government	Water services authorities, water service providers.
Water Industry suppliers and providers	Consultants, Contractors, Manufacturers, Value Added Resellers, Bulk and Small Suppliers of goods and services.
Government Departments directly affected by	Water Affairs & Forestry, Health, Local Government & Provincial Affairs, National Treasury and Labor Services.
Government Departments indirectly affected by	Education, Environment Affairs & Tourism, Housing, Land Affairs, Revenue Services and Social Development
Water Services Communities	SALGA, WRC, SABS, WISA and IMESA

4.3.5. Environmental Implications

Improvement of water services may increase water consumption, thus decreasing the water levels in dams and rivers and impacting negatively on the aquatic life. South Africa is a water-scarce country and any change of water services needs to take into account water balance projections. In addition South African groundwater is one of the most contaminated in Africa. The improvement of water systems necessitates strong management otherwise this may have negative implication on environmental sustainability by causing water exploitation, pollution, etc. Through the process of protecting the area around the water system, an environment crucial for water quality, the water projects have a potential to promote an awareness of the relationship of water access with the surrounding natural environment.

Decreasing water flows in rivers will impact upon natural plant communities through impacts on water quality in the riparian area of rivers. The effects on the ecosystem of the indigenous and exotic vegetation are expected to result in a poorer environment that will support less vigorous plant communities. Other impacts may include the extent of deforestation; the soil fertility, the value of changes in land use and the risks of disasters (e.g. flooding or landslides). Investments in water resource development and water supply infrastructure typically have negative impacts on the environment. These include reduction or alteration of river flows (resulting in a degradation of the aquatic ecosystem, deterioration of water quality as a result of reduced assimilation capacity and increased water use) and the loss of species.

4.2 Socio-Economic Benefits of Raising the Basic Level of Services

Raising the basic level of water services has several benefits, both in the water resources and services arenas.

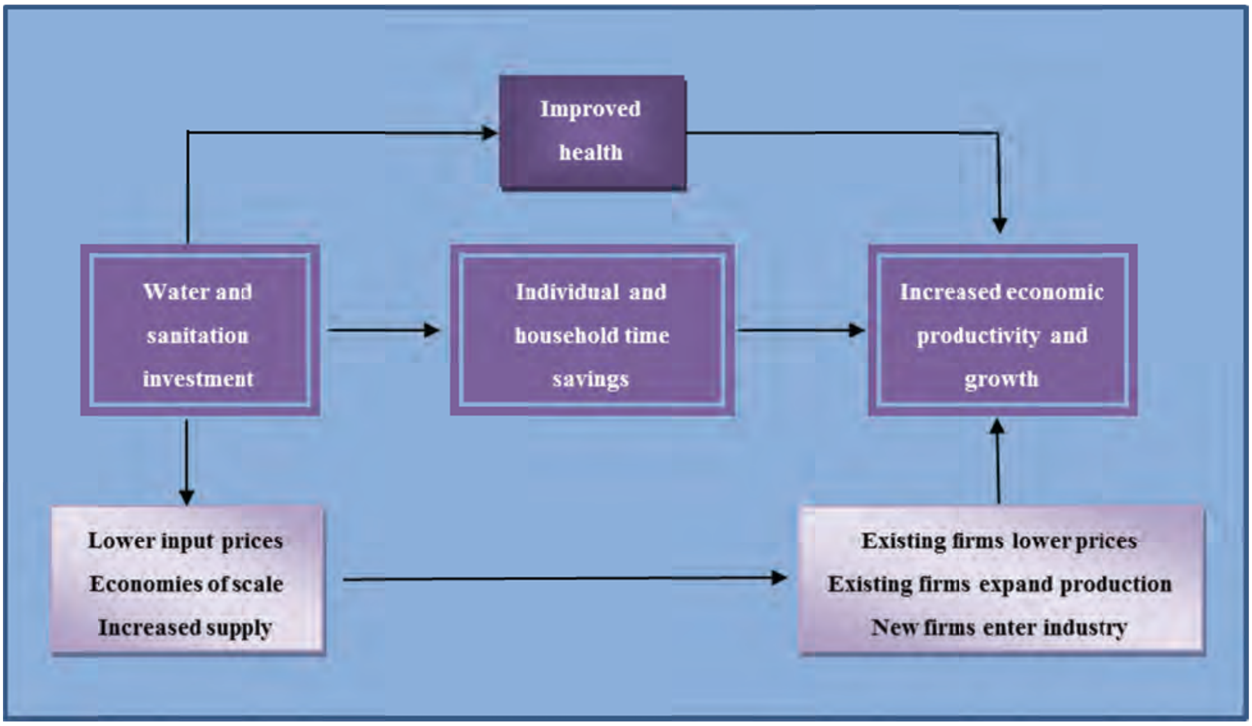
The social implications related to raising level of water services include: time saving (impacting on education, social empowerment and maternal health); health (decreasing child mortality, malaria, etc.); nutrition (through home gardens and livestock), social empowerment (and gender equality) and the decrease of vulnerability (home gardens, livestock).The lack of access to safe water and hygiene practices is the third most significant risk factor for poor health in South Africa with high mortality rates. Diarrhoeal disease, for example, is widely recognised as the principal result of inadequate water. Van Koppen (2009) noted that 1.8 million people die every year from diarrhoeal disease; 90% of whom are children under the age of 5. Sustainable access to water alleviates collection responsibilities for the community, especially women and children. Table 19 below details some social implications likely to result because of increasing level of water services.

Table 15: Social Implications

Social Dimension	Household direct and indirect implications
Poverty	Indirect impact through increased time for productive activities.
Food security/ nutrition	Indirect impact on nutrition through better absorption of nutrient due to less diarrheal diseases.
	Direct impact through household consumption of vegetable, fruits, livestock products.
Health	Direct impact through reduced water-related diseases.
	Indirect health improvement through better nutrition.
	Reducing child mortality by enhancing health and income for child care.
	Improving maternal health, by reducing women's domestic chores and improving access to water for productive purposes.
	Alleviating HIV/AIDS, malaria and other diseases, by reducing burdens of water

	fetching, avoiding dehydration, accommodating higher hygiene requirements.
	Increased length of life, medical costs avoided, reduced time spent in health care, reduced travel costs for health care seeking, increased productivity and reduced sick leave.
Vulnerability	Direct impact on to vulnerability natural conditions (drought).
	Reduced economic and health vulnerability (home gardens & livestock made less vulnerable to drought – ensuring food security and income).
	Reduced vulnerability to water diseases and physical vulnerability for women girls when fetching water.
	Reduced social vulnerability (especially for women).
	Decrease vulnerability by allowing more diversified livelihood strategies.
Gender equality	Direct impact through access to water (equitable)
	Indirect impact through improved bargaining power (often for women).
	Promoting gender equality by reducing women's excessive domestic chores and improving access to water for productive purposes for both women and men.
Education	Achieving universal primary education by alleviating the burden on children in fetching water or herding cattle.
	Improved water services also reduce school absenteeism

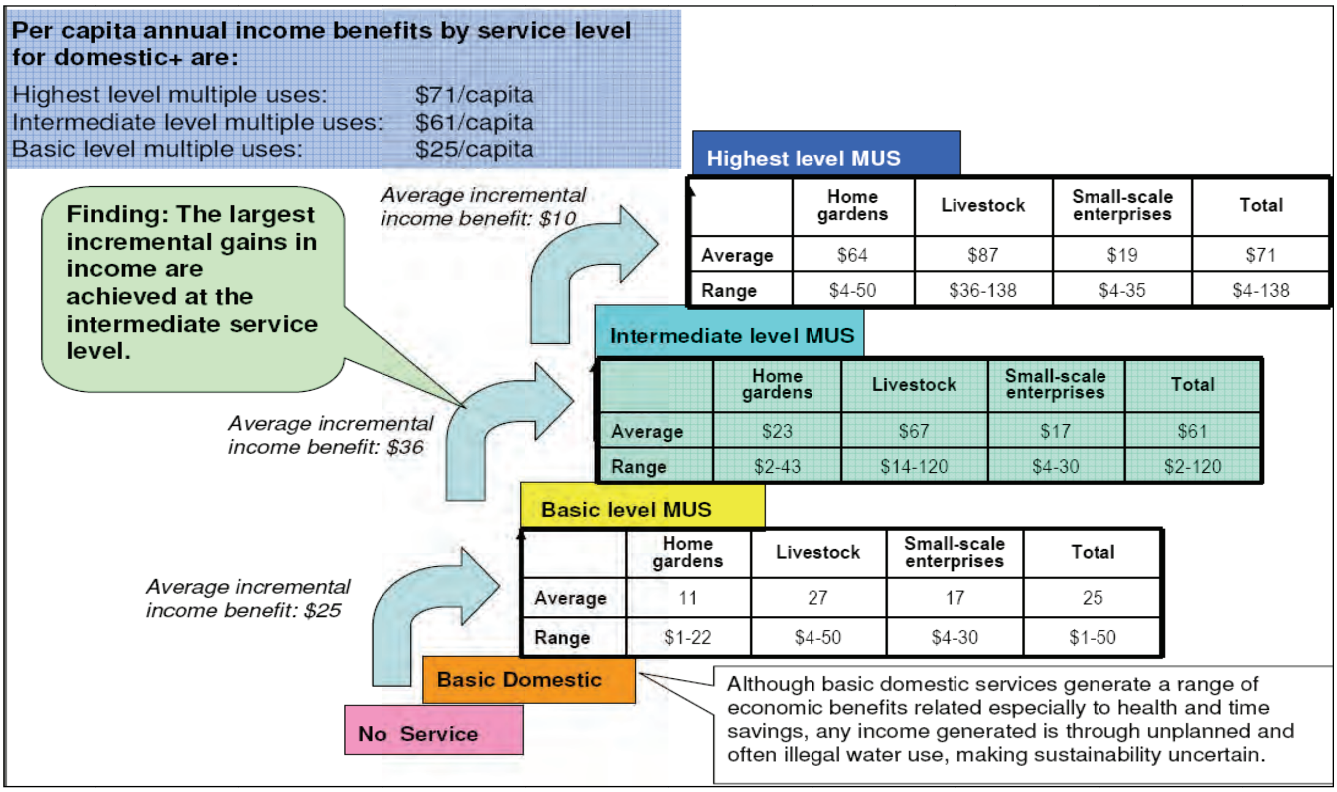
Further, the close proximity of safe water systems is related to increased wealth and production capacity of vegetables and livestock (Renwick et al., 2007). The management of water resources for growth and increased productivity in the agricultural and agricultural growth will encompass improving water-use efficiency and the matching of water use with what regional water resources are able to provide. Sustainable growth will encompass protecting farmers, ranchers and fishermen from rainfall variability and extreme events such as floods and droughts. Improved water services enhance the productivity of these assets, achieving multiple poverty impacts — on income, food security/nutrition, health, reduced vulnerability and livelihoods diversification, and social equity and empowerment (ibid). Homestead-scale production strengthens people's resilience when faced with external shocks from climate change, increasing food prices or volatile economies. Activities are diversified and can be swiftly changed. For food producers, higher food prices imply higher incomes if new markets can be accessed, while expenditure can be reduced by using homestead produce for family consumption. The latter is even more important for poor people who are net food buyers in urban and rural areas and who suffer most from high food prices because they spend a much larger proportion of their income on food (van Koppen, 2009). More successfully raising the level of water services reduces poverty by simultaneously addressing multiple dimensions of poverty (Renwick et al., 2007). Eberhardt and Pegram (2000) have summarised the overall economic benefits associated with investment in water and sanitation services in the following Figure.



Source: Eberhardt and Pegram (2000).

Figure 2: Economic benefits from water improvement

By addressing multiple dimensions of poverty, poverty is more effectively reduced. An example thereof, drawn from Renwick is illustrated below:



Source: Renwick et al., 2007

Figure 3: Per-capita Annual Income Benefits by Service Level

In South Africa, 60% of households with higher level multiple-use services are engaged in 2 water-dependent enterprises, compared with only 38% of those with lower level services (Renwick et al., 2007). Homestead-scale MUS meets domestic water needs. The importance of this hardly warrants further explanation. However, for comparison in water productivity assessments, one CPWF-MUS case study tried to express the value of domestic water uses in monetary terms. Van Koppen et al., (2009) defined domestic use of water as the amount of water used for drinking, cooking, bathing, washing clothes and utensils, food processing, brewing, house construction and production of handicrafts, and he attributed economic values to these activities. He arrived at a productivity of domestic water of US$ 22 per cubic metre of water, much higher than the water productivities he estimated for crop and livestock production of US$ 0.8 and US$ 4.2 per cubic metre respectively (ibid).

The choice of productive activity for income generation depends on the local market, tradition, individual initiative, and a perceived need for an income. However, the most profitable water-based activities, in terms of income per unit of water, are uncommon because there are often only few opportunities for such businesses in a community and they may require more capital and knowledge to start up (Renwick et al., 2007). Among the array of benefits from productive water uses, the case studies found that increased household food security, income generation, and empowerment of women were the most common. Productive activities increased household food security, although the proportion of the households in the case study communities that grow their food or breed animals is quite variable. Gardens in the study area in South Africa are mainly used to grow vegetables and legumes which otherwise would not be bought in such quantities, while raising small animals provides milk, eggs, and meat (ibid).

4.4. National Financial Water Services Picture

The budget summary for the Department of Water Affairs, tasked with ensuring the availability and supply of water at a national level, as well as the sufficient supply of water services at a local level, is given in Table 18 below.

Table 16: The Water Affairs Budget – Estimates of National Expenditure

R million	2010/11				2011/12	2012/13
	Total to be appropriated	Current payments	Transfers & subsidies	Payments for capital assets	Total	Total
MTEF allocation						
Administration	884.2	833.6	11.7	38.9	902.1	947.8
Water Management	364.7	355.8	0.8	8.2	386.6	405.9
National Wate Resources Infrastructure Programme	2 241.4	-	2 241.1	-	2 520.2	2 740.0

Regional Management	4 329.0	2 303.9	948.5	1 076.6	5 077.3	5 320.5
Water Secto Regulation	177.2	139.5	36.1	1.6	201.0	214.1
Total expenditure estimates	**7 996.6**	**3 632.8**	**3 238.5**	**1 125.3**	**9 090.2**	**9 628.2**
Source: The Estimates of National Expenditure 2010, Vote 37: Water Affairs – available at www.statssa.gov.za						

Table 19 below provides an estimate of the overall size of the water services sector in South Africa. This estimate provides the size of the water services asset base, the annual expenditure (investment) in the water services sector, as well as the number of people directly employed in the sector.

Table 17: Estimate of the overall size of the water services sector

[R million]	DWAF	Water Boards	Municipalities	Total
Assets (R million)	40 000	11200	± 50 000[a]	± 100 000
Investment (R million pa)	1 200	1 000	2 500	5 000
Turnover (R million pa)	1 700	3 500	6 800	10 000
Staff numbers	21 700 [d]	8 000	± 40 000[e]	70 000
Volume (million kl pa)				3 300 [f]

Source: DWAF, 2003.

4.5. Summary of the Literature Based Implications

The figure below summarises the implications of raising the basic level of water services highlighted in the literature.

The figure highlights the technical, human, financial, environmental and water as well as institutional impacts,

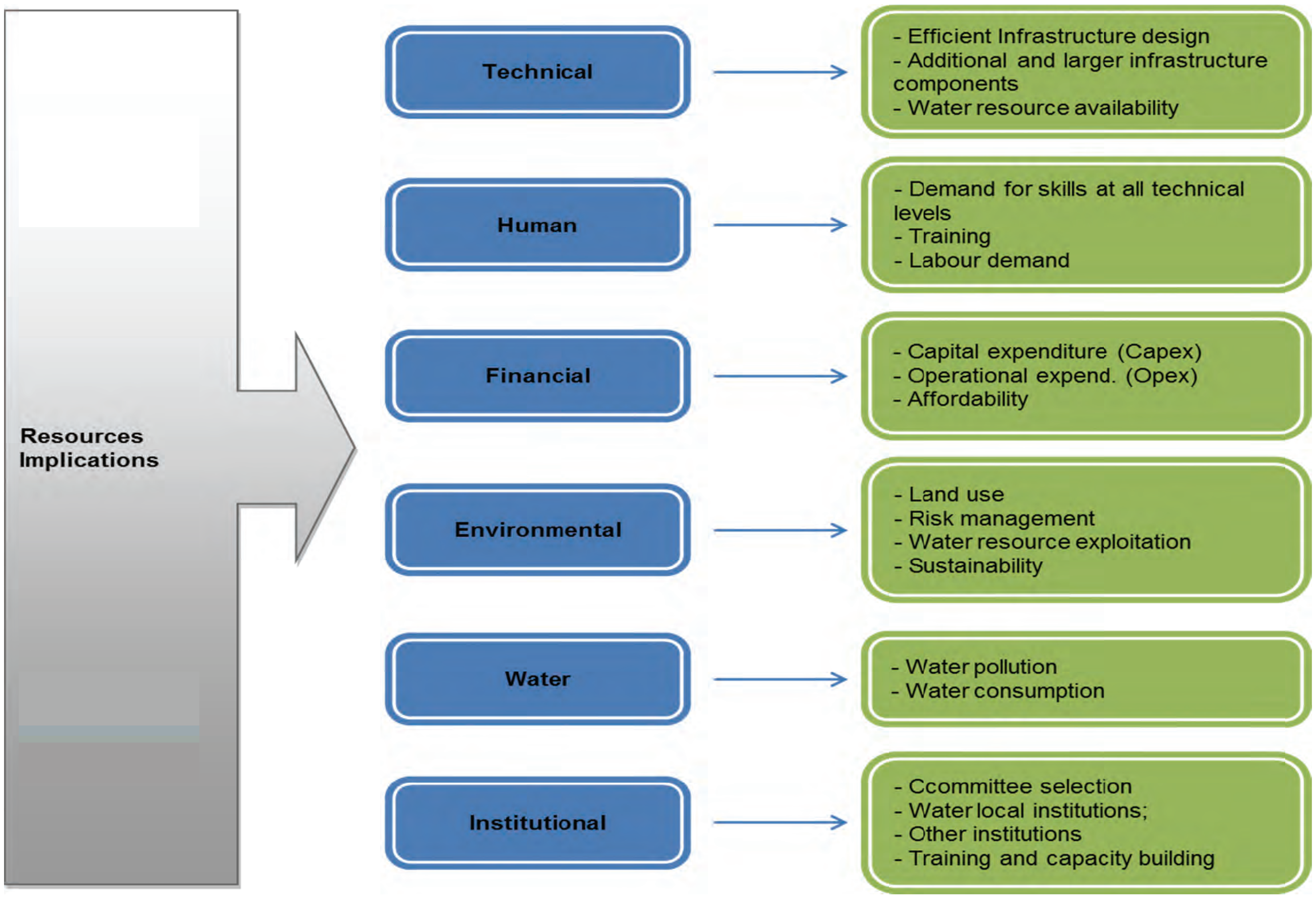


Figure 4: Summary of Implications of Raising the Basic Level of Water Services

5. CASE STUDY OF DITSOBOTLA LOCAL MUNICIPALITY

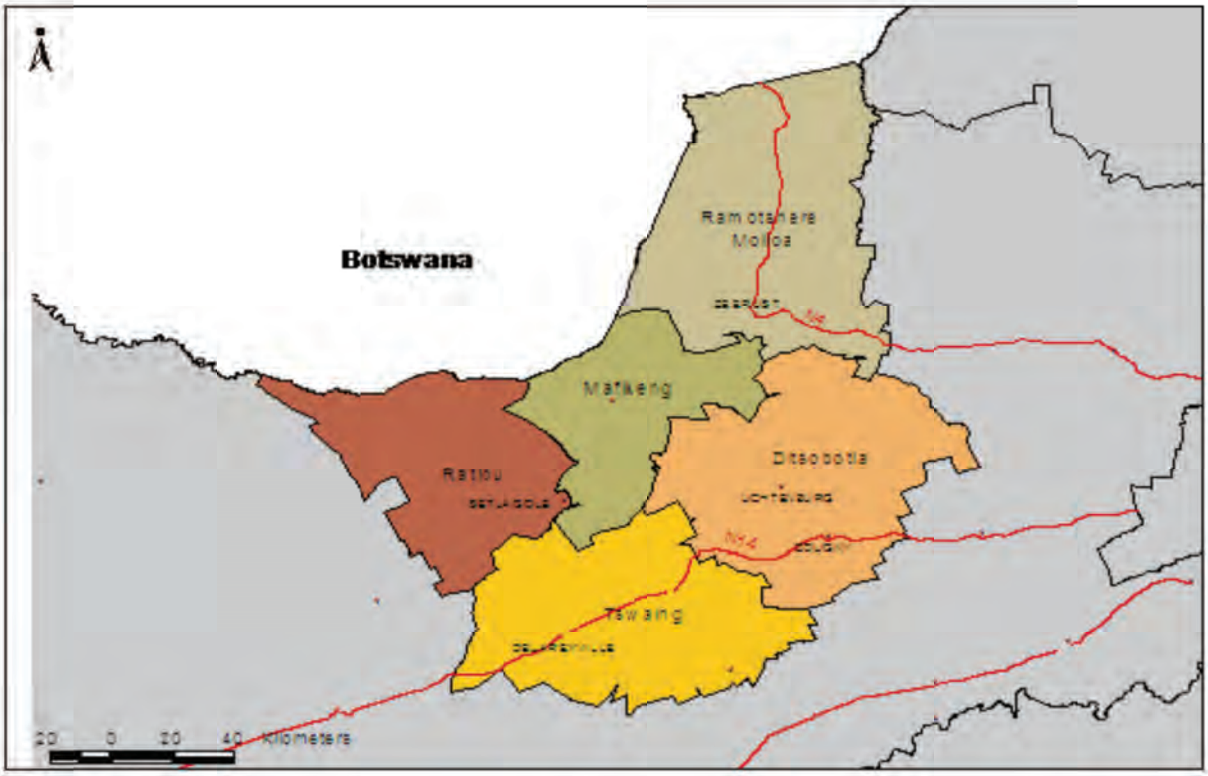
5.1. Introduction

This section seeks to contextualise the study by developing a profile that captures the relevant socio-economic characteristics and the level of basic water and sanitation services of the case study. This information provides an understanding of the level of the basic services within a South African local municipality in which has emerged the development of a model for raising the basic level of water services which will be used as standard for all South African local municipalities.

5.2. Background and Characteristics

The case study of Ditsobotla Local Municipality (DLM) formerly Lichtenburg falls within the Ngaka Modiri Molema District Municipality in the North-west province. The Ditsobotla Local Municipality was established through the amalgamation of the former Lichtenburg, Coligny and Biesiesvlei Transitional Councils. The Ditsobotla Local Municipality is illustrated by the map in Figure 6 below. In 2007, the population of DLM was estimated at 200 141 people distributed within 38 608 households. The Municipality records an average household size of 4.8 compared to a slightly higher average of the district municipality which is 5.0. (DLM, 2010).

A review of the Ditsobotla Integrated Development Plan (DLM IDP, 2010) indicated there is a slight dominance of females at 51% in comparison with 49% of males in the municipality and the age profile of the municipality indicates that its population remains fairly young with people of 19years and younger constituting 43.5% of the total population. The proportion of the population aged 40-49 years stands at 17.1% while those over 60 years are at a marginal 7.5%. The age category of 5-19 years is 33.1%. Approximately 77.5% of the households earn less than R1 600 per month. While this figure is lower than that of the district municipality, it is higher than the provincial figure of 73.17%; the percentage of people without income is estimated at 35%. This trend is similar to that of the North West Province and the District Municipality and the above figures indicate the pressure placed on the Ditsobotla Local Municipality regarding revenue enhancement and expansion of service delivery infrastructure (DLM IDP, 2010).



Source: Ngaka Modiri Molema District Municipality IDP 2007-2011

Figure 5: Locality map of Ditsobotla within Ngaka Modiri Malema District Municipality

The Ditsobotla area consists of a predominantly rural or agricultural base with a higher level of unemployment and poverty characterized by a lack of access to the basic services including water and sanitation (DLM IDP, 2010).The economic sector within which the economically active population of Ditsobotla Local Municipality is involved indicates that the majority of population is involved in the agricultural sector (24.15%), private households" (18.85%) and community and personal services sector (16.02%).Therefore the municipality is characterized by high unemployment levels with about 42.5% of the economically active population classified as unemployed which is slightly lower than the provincial average of 43.77% and nearly 5% lower than that of the average of the Ngaka Modiri Molema District Municipality (ibid).

According to the DLM IDP (DLM IDP, 2010), the high levels of poverty and unemployment within the area remains a serious challenge with over 70% of households earning less than R1 500 per month. The highest employment is in the Itsoseng, Sheila, Springbokpan and Meetmekaar areas. However, in Bodibe, the unemployment rate stands at 55%. As illustrated in the Figures below, the main challenges of DLM and top priorities for DLM next year are service delivery including water and sanitation and infrastructure backlogs that have the propensity of negatively affecting the integrated human settlement (ibid). There is a need for raising the basic level of water and sanitation services in the area; a considerable proportion of residents without basic services of water, electricity, refuse removal and formal housing is prevalent in the rural parts of Bodibe, Verdwaal, Bakerville, Grasfontein, Itsoseng (water), Itekeng and other areas; a serious backlog in terms of housing, water and sanitation provision is prevalent in the areas of Biesiesvlei, Tlhabologang, and Boikhutso and other parts of the municipality where there is no proper settlement (ibid).

5.3. Level of Services Provision in the Ditsobotla Local Municipal

5.3.1. Settlement

In terms of dwellings type, the 2007 Community Survey has indicated that North-West has the highest percentage of municipalities having households living in formal dwellings which stands at 76.2% above the provincial average of 66.5%.The Ditsobotla Local Municipality is slightly below the provincial average by 5% and stands at 71.1% (2007) .This figure is largely due to the migration of farm-workers from their original workplaces into the former townships which resulted in squatting in areas such as Tlhabologang, Itekeng and Boikhutso as a result of which the informal dwellings have increased from 16.6% in 2001 to 23.6% during 2007 (DLM, 2010). As illustrated in Table 31 below, a significant number of stands for residential purposes are found in Bakerville and Carlsonia (97%) (ibid).

Table 18: Representation of residential components per settlements

Residential Clusters	Residential Sites	Non-residential sites	Total Sites	% residential sites	% non-residential sites
Lichtenburg/Boikhutso	7 330	1 853	9 183	79.82	20.18
Itsoseng/Verdwaal/Sheila	6 636	951	7 587	87.47	12.53
Coligny/Tlhabologang	2 134	435	2 569	83.07	16.93
Itekeng/Biesiesvlei	520	39	559	93.02	6.98
Ga-Motlatla	432	17	449	96.21	3.79
Bodibe/Welverdiend	6 003	313	6 316	95.04	4.96
Bakerville	726	20	7 46	97.32	2.68
Total Population	**23 781**	**3 628**	**27 409**	**86.76**	**13.24**

Source: DLM, IDP Review 2010

5.3.2. Water and Sanitation

As mentioned in the previous paragraph of this section, service delivery is one of the main challenges in the DLM and these include water and sanitation services. Although significant progress has been made in providing portable water to the municipal communities; these remain the most critical key performance areas of the municipality as a water services provider. According to the recent Community Survey 2007, the number of households receiving piped water increased from 82.4% in 2001 to 93.6% in 2007. Without necessarily disputing these statistics, they seem to be misleading as almost the entire Bodibe Village, for example, which has almost 2 000 households, has no RDP standard water provision (DLM, 2010)

Regarding access to water, Table 32 below indicates that only 29 % of the households in the DLM had access to water inside their houses, 29% had access to water in the yard, 14% in nearby community standpipes and 11% to community standpipes over 200 m distant. A further 14% had access to water through un-improved sources including boreholes, springs and rain tanks. Regarding access to sanitation, it is indicated below that only 43% of the households in the DLM had waterborne sewerage, 34% use pit latrines and the remaining 30% had access to un-improved sanitation such as the bucket system and no formal access. This data indicates that there is a real need for to achieve the existing level of basic water service, in this, and many other South African local municipalities.

Table 19: Access of Households in the DLM to Water and Sanitation Services

Water	Percentage	Sanitation	Percentage
Inside the House	28.6	Flush Toilet	42.8
In the Yard	29.3	Flush Septic Tank	2.4
Community Stand	13.9	Chemical Toilet	3.4
Community Standpipe over 200 m	10.6	VIP	6.7
Borehole	13.1	Pit Latrine	27.4
Spring	0	Bucket Latrine	8.1
Rain Tank	0.5	None	9.3

Source: Adapted from Ngaka Modiri Molema District Municipality – IDP 2007-2011

Although, the figures above indicate that water and sanitation levels are above the existing basic level of water service; there are still challenges with water and sanitation provision in these areas. Consequently, the major concern in DLM is those people receiving water from natural sources such as rivers, dams, and springs, it is these people who are susceptible to disease. The levels of standard in this regard will differ from village to village depending on the availability of funds, the type of settlement, topography, and what people can afford. Access to sanitation services in DLM is dictated by the availability of bulk treatment capacity, thus, the level of urbanisation; higher order sanitation services are predominantly available in the urban clusters in the DLM area (DLM, 2010).

Table 20: Basic water supply backlog in DLM

Area	Total Number Households	Current Level of Service	Households Below RDP	Above RDP
WARD 1				
Boikhutso Extension 2	500	Yard Taps	200	300
Boikhutso Proper	4 640	Yard Taps	2 040	2 600
WARD 2				
Boikhutso	4 300	Yard Taps	1 520	2 780
WARD 3				

Area	Total Number Households	Current Level of Service	Households Below RDP	Above RDP
Blydeville	2 840	Yard Taps	496	2 344
WARD 4				
Burgersdorp	2 400	Yard Taps	0	2 400
Part of Town	80	Yard Taps	0	80
Blydeville Extension 3	620	Yard Taps	0	620
WARD 5				
Lichtenburg CBD	2 800	Yard Taps	0	2 800
Neighbouring Farms	220	Yard Taps	220	0
WARD 6				
Itsoseng Zone 3	4 411	Yard Taps	0	4 411
Sheila Village	377	Boreholes	377	0
WARD 7, 8 & 9				
Itsoseng Zone 1	1 184	Yard Taps	0	1 184
Itsoseng Zone 2	2 804	Yard Taps	0	2 804
WARD 10				
Verdwaal 1 & 2	3 200	Yard Taps	2 400	800
WARD 11				
Itekeng Proper	507	Yard Taps	0	507
Itekeng Extension 2	421	Yard Taps	0	421
New RDP Extension	278	Tanks	0	278
WARD 12				
Tlhabologang Ext 5	1 233		0	1 233
WARD 13				
Ga-Motlatla	573	Boreholes	573	0
Bakerville	330	Boreholes	330	0
Welverdiend	80	Boreholes	80	0
WARD 15 & 16				
Tlhabologang Ext 3 & 4	654	Yard Taps	0	654
Soul City	216	Yard Taps	0	216
WARD 17 & 18				
Bodibe	3 190	Yard Taps	3,190	0
WARD 19				
Matile 1 & 2	420	Boreholes	420	0

Area	Total Number Households	Current Level of Service	Households Below RDP	Above RDP
Springbokpan	573	Boreholes	573	0
Meetmekaar	158	Boreholes	158	0
Bodibe/Kgomola	5 168	Boreholes	5 168	0
Total	38 582		18 023	20 559

Source: DLM, IDP Review 2010

According to the DLM IDP (DLM IDP, 2010), the Lichtenburg water treatment plant is over fifty years old which is a real challenge for water infrastructure, but in general the overall physical condition of this plant is good and the infrastructure is well maintained with an annual maintenance cost estimated at R1 million (DLM , 2010). The pump station in Itsoseng is in an average condition and requires overhaul and maintenance. Regarding sanitation backlogs, the largest ones are found in rural areas and in some urban areas with informal settlements. The urban areas with some levels of informal settlement include Tlhabologang, Itekeng, and Boikhutso where minimum RDP standards of sanitation are still lacking. Whilst the backlog has declined considerably from 19 485 in 2001 to 10 274 in 2007, there seems to be huge sanitation needs in rural areas (ibid).

Table 21: Basic Sanitation supply backlog in DLM

Area	Total Number Households	Current Level of Service	Households Below RDP	Above RDP
WARD 1				
Shukran	500	Pit	200	300
Boikhutso	4640	Buckets	2 040	2 600
WARD 2				
Boikhutso	4 300	Buckets	1 520	2 780
WARD 3				
Blydeville	2 840	Buckets	496	2 344
WARD 4				
Burgersdorp	2 400	Waterborne	0	2 400
Part of Town	80	Waterborne	0	80
Blydeville Extension 3	620	Waterborne	0	620
WARD 5				
Lichtenburg CBD	2 800	Waterborne	0	2 800
Neighboring Farms	220	Pit	220	0
WARD 6				
Itsoseng Zone 3	4 411	Waterborne	0	4 411

Area	Total Number Households	Current Level of Service	Households Below RDP	Above RDP
Sheila Village	377	Pit	377	0
WARD 7, 8 & 9				
Itsoseng Zone 1	1 184	Waterborne	0	1 184
Itsoseng Zone 2	2 804	Waterborne	0	2 804
WARD 10				
Verdwaal 1 & 2	3 200	VIP	40	0
WARD 11				
Itekeng Proper	507	Pit	507	0
Itekeng Extension 2	421	Pit	421	0
New RDP Extension	278	Pit	278	0
WARD 12				
Tlhabologang Extension 5	1 233	Waterborne	0	1 233
WARD 13				
Ga-Motlatla	573	Pit	0	573
WARD 14				
Bakerville	330	Pit	330	0
Welverdiend	80	Pit	80	0
WARD 15 & 16				
Tlhabologang Extension 3 & 4	654	Waterborne	0	654
Soul City	216	Waterborne	216	0
WARD 17 & 18				
Bodibe	3 190	Pit	3 190	0
WARD 19				
Matile 1 & 2	420	Pit	420	0
Springbokpan	373	Pit	373	0
Meetmekaar	158	Pit	158	0
Bodibe/Kgomola	5 168	Pit	5 168	0
Total	38 582		10 274	25 138

Source: DLM, IDP Review 2010

The minimum cost for the eradication of the sanitation backlog within the DLM assumes that a Ventilated Improved Pit Latrine structure costs R7 875 and upgrading to waterborne sewerage is R3 000 per unit and R46 233 000 per 10 274 households below RDP and R80 907 750 for upgrading VIP sanitation backlog (DLM, 2010).

5.3.3. Environment Issues

The Ditsobotla Local Municipality is facing real environmental concerns which affect water and sanitation sector, these include: local surface water, ground water and waste management as briefly discussed in the paragraph below.

a. Local Surface Water

The DLM surface water is a potentially most serious risk to health. It is caused by uncontrolled garbage and its effect on the storm water system. According to DLM (2010) increased waste matter, together with loose soil in DLM lead to blockages in the storm water drainage system which means that storm water cannot drain away and thus becomes standing water, contaminated with pathogens from decaying waste and human and animal excreta. The level of contamination will be particularly high if sanitation is inadequate. Contaminated standing water exposes residents to the risk of many “faecal-oral” diseases, including, not only cholera and typhoid fever, but also more common ones such as intestinal parasites and diarrheal diseases (ibid).

b. Groundwater

The DLM is also suffering with ground water challenges. Uncollected household waste is being dumped in watercourses and storm water drains and it is also dumped on open ground which can lead to contamination of the local groundwater systems, posing a threat to the health of humans or livestock if that groundwater is accessed for domestic or agricultural use (DLM, 2010).The problems associated with standing water transfers into water quality problems in the storm water channels, streams and rivers (ibid).

c. Waste Management

According to DLM-IDP 2010, the total number of households receiving a regular waste removal service in the municipality has increased from 41.5% to 56.2% in 2007 but there is also a slight increase in the number of households without refuse disposal from 11% to 15.6% during the same period (DLM, 2010). The Integrated Waste Management Plan of the Ngaka Modiri Molema District Municipality prepared by Steffen, Robertson & Kirsten during 2005 identified a number of physical aspects and pressures on the environment resulting from inappropriate environmental management practices, all of which are applicable to the Ditsobotla Local Municipality (NMDM – IDP, 2007-2011).

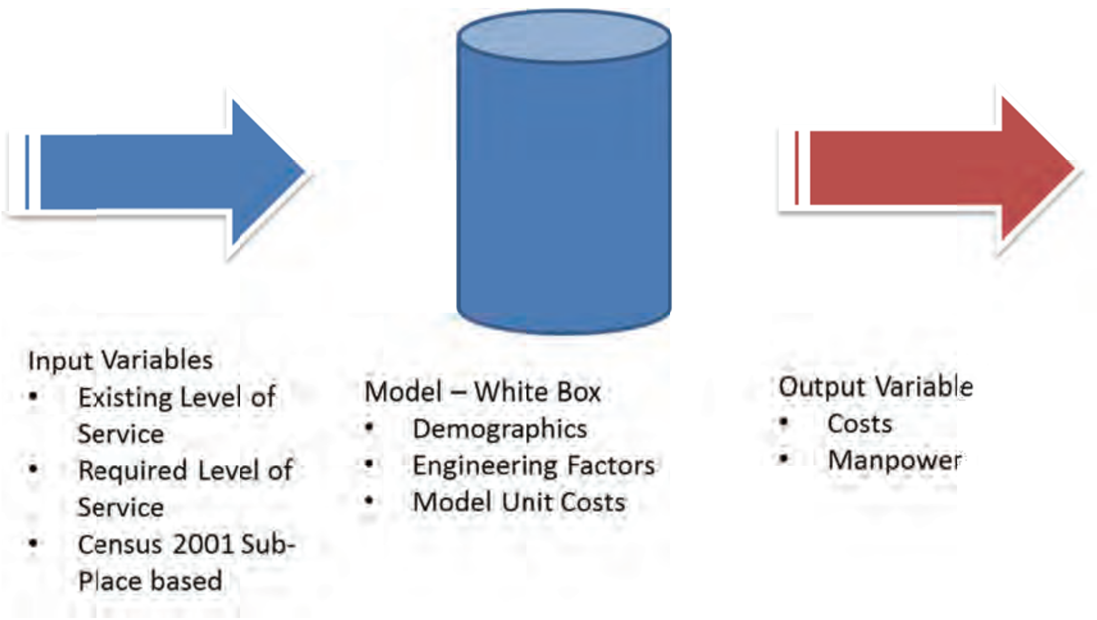
6. MODEL DESIGN AND RESULTS

6.1. Model Monogramme

The model has been derived to demonstrate the implications of raising the basic level of service for the Ditsobotla Local Municipality.

The model includes the water services implications as well as the sanitation service implications. The model allows users to input required water services scenarios and the output is given as a cost for each required level of service. In addition to the cost implications for the level of service, the model also raises a number of flags to highlight issues that cannot be captured as a cost.

The model's basic operation is described in the Figure below.



The model uses the following overall approach to the analysis.

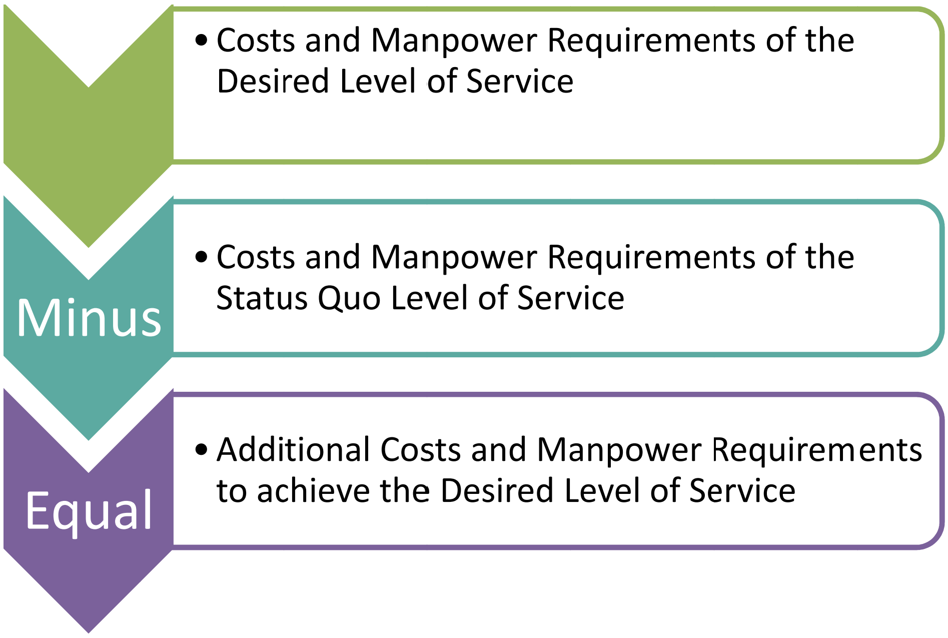


Table 22: Internal Model Variables

	No Service (< RDP)	Communal Standpipe	Yard Tap	Household Connection
Water Services	No Service	6kl/hh/month	9.6kl/hh/month	33.6kl/hh/month
Sanitation Services	No Service	Dry Systems	Dry Systems	Waterborne

When considering the information required by the model, it was decided to use information that is generally available from sources other than the municipality. In this way, the model could still be used even if the municipality has very little information on its water services system. This approach would not exclude the municipality that gathers and documents all the necessary water services information. The information to be used in the model would be more accurate, at a more local scale and be more up to date. This would yield more accurate results from the model.

The model uses the Census 2001 sub-place as its basic measurement area. All information used in the model is provided at this level of detail. The choice of the sub-place as the basic unit took into account the following factors:

- It is a commonly used unit of area, for which accurate and reliable information exists;
- It is the smallest unit available for which detailed information exists, thus there is less need for averaging as if a larger unit, such as a Main Place had been used; and
- The area is objective, and thus is not influenced by user subjectivity.

Population demographics used in the model are the following:

- Population size, given as a number of households;
- The household density within a given sub-place; and

- Whether the sub-place is rural or urban. The so-called 1996 definition" used in Census 2001 data is used for this since it provides a land-use density definition rather than the alternative, population density, definition.

The demographics are provided in the model, and the Table below shows some of the input data to the model.

Table 23: Example of Model Input Data

Municipality	Main Place	Main Place Code	Sub-Place Name	Sub-Place Code	Rural/Urban [1996]	Total	Area [ha]	HH Density [hh/ha]	Low Income [0-R38 000 pa]	Medium Income [R38 000 to R153 000 pa]	High Income [R153 000 and above]
Ditsobotla	Bakwena Ba GaSerobatse	60901	Ga-Motlatla	60901001	Rural	400	238	1.7	382	14	4
Ditsobotla	Banogeng	60902	Matile	60902001	Rural	105	72	1.5	102	3	0
Ditsobotla	Boikhutso	60903	NONE	60903000	Rural	3 014	185	16.3	2 737	262	15
Ditsobotla	Boikhutso	60903	Boikhutso	60903001	Rural	953	39	24.7	874	79	0
Ditsobotla	Coligny	60904	NONE	60904000	Urban	1 676	351	4.8	1 486	163	27
Ditsobotla	Ditsobotla	60905	Lichtenburg NU	60905001	Rural	11 122	467 012	0.0	10 415	540	167
Ditsobotla	Ditsobotla	60905	Madikwe NU	60905002	Rural	218	98 746	0.0	201	17	0
Ditsobotla	Ditsobotla	60905	Rustenburg NU	60905003	Rural	368	69 404	0.0	334	23	11
Ditsobotla	Ga-Raphalane	60906	Bodibe	60906001	Rural	4 798	2 645	1.8	4 585	182	31
Ditsobotla	Itekeng	60907	NONE	60907000	Rural	549	36	15.4	524	25	0
Ditsobotla	Itsoseng	60908	Itsoseng 1	60908001	Rural	2 190	304	7.2	2 004	168	18
Ditsobotla	Itsoseng	60908	Itsoseng 2	60908002	Rural	751	170	4.4	495	245	11
Ditsobotla	Itsoseng	60908	Itsoseng 3	60908003	Rural	2 854	292	9.8	2 182	631	41
Ditsobotla	Kopano	60909	Sheila	60909001	Rural	303	253	1.2	284	19	0
Ditsobotla	Kopano	60909	Verdwaal	60909002	Rural	1 283	364	3.5	1 247	28	8
Ditsobotla	Kopano	60909	Welverdiend	60909003	Rural	147	63	2.3	140	7	0
Ditsobotla	Lichtenburg	60910	NONE	60910000	Urban	1 624	8 157	0.2	790	604	230

Municipality	Main Place	Main Place Code	Sub-Place Name	Sub-Place Code	Rural/Urban [1996]	Total	Area [ha]	HH Density [hh/ha]	Low Income [0-R38 000 pa]	Medium Income [R38 000 to R153 000 pa]	High Income [R153 000 and above]
Ditsobotla	Lichtenburg	60910	Blydeville	60910001	Rural	323	85	3.8	253	65	5
Ditsobotla	Lichtenburg	60910	Burgersdorp	60910002	Urban	1 167	376	3.1	529	478	160
Ditsobotla	Lichtenburg	60910	Burgersdorp Ext 4	60910003	Rural	136	99	1.4	50	71	15
Ditsobotla	Lichtenburg	60910	Shukran	60910004	Urban	106	32	3.4	58	26	22
Ditsobotla	Mosiane	60911	Matile	60911001	Rural	269	174	1.5	266	0	3
Ditsobotla	Tlhabologang	60912	NONE	60912000	Rural	1 220	64	19.2	1 146	69	5

The water services detail that is required by the model is all based on the sub-place level of detail and are:

- Water services information given at a household level. This information has been summarised into four categories – below RDP service (No service), Communal Standpipes, Yard Taps and House connections; and
- Sanitation services information given at a household level, this information has been summarised into three categories – Unimproved (which is all levels lower than VIP toilets), this was classified as “No Service”, Dry sanitation (which covers VIP toilets), as well as Intermediate Systems (which includes chemical toilets and septic tank based toilets) and Waterborne (which covers flush toilets connected to a formal sewer), this was classified as “House Connection”

The engineering factors are basic water design factors that are needed to size water service infrastructure. These factors are derived from standard engineering practice in South Africa and follow the standards provided in the *“Guideline for Human Settlement Planning and Design”* commonly known as the Red Book. Other information has been taken from *“Municipal Infrastructure – An Industry Guide to Infrastructure Service Delivery Levels and Unit Costs”,* more commonly known as the *Industry Guide* as well as the “*Technical guidelines for the development of water and sanitation infrastructure*” as developed by DWA.

The factors used in the model are:

- Basic water demand figures provided as an input to the model or an estimated figure for each Level of Service per capita per day;
- Gross Annual Average Daily Demand factor of 10%;
- Summer daily demand factor of 30% for bulk water pipelines;
- Water and Sanitation scheme size categorisation using the sizing provided in the Industry Guide;
- Reservoir storage requirement of 48 hours of the annual average water demand;
- Water treatment demand factor of 30% of the base water demand;
- Household sanitation flows for the various levels of service;
- Sanitation peak daily flow factor was calculated based on the number of households;
- Sanitation peak wet weather flow factor of 15%; and
- The engineering useful life of each category of physical asset.

The Tables below show the water and sanitation services status quo in the study area.

Table 24: Water and Sanitation Status Quo in the DLM

Municipality	Main Place	Main Place Code	Sub-Place Name	Sub-Place Code	Rural/ Urban [1996]	Total	Area [ha]	HH Density [hh/ha]	Low Income [0-R38 000 pa]	Medium Income [R38 000 to R153 000 pa]	High Income [R153 000 and above]	Piped water inside dwelling	Piped water inside yard	Communal SP < 200 m	Communal SP > 200 m	Borehole	Unimproved	No Service (Below RDP)	Dry	Intermediate	Waterborne
Ditsobotla	Bakwena Ba GaSerobatse	60901	Ga-Motlatla	60901001	Rural	400	238	1.7	382	14	4	8	279	62	23	0	390	85	279	12	14
Ditsobotla	Banogeng	60902	Matile	60902001	Rural	105	72	1.5	102	3	0	0	16	3	0	81	22	84	16	0	3
Ditsobotla	Boikhutso	60903	NONE	60903000	Rural	3 014	185	16.3	2 737	262	15	998	1727	181	54	0	3237	235	1727	1013	262
Ditsobotla	Boikhutso	60903	Boikhutso	60903001	Rural	953	39	24.7	874	79	0	134	80	217	279	0	789	496	80	134	79
Ditsobotla	Coligny	60904	NONE	60904000	Urban	1 676	351	4.8	1 486	163	27	414	94	721	193	3	1612	917	94	441	163
Ditsobotla	Ditsobotla	60905	Lichtenburg NU	60905001	Rural	11 122	467 012	0.0	10 415	540	167	2223	2954	2200	2072	1162	10156	5434	2954	2390	540
Ditsobotla	Ditsobotla	60905	Madikwe NU	60905002	Rural	218	98 746	0.0	201	17	0	31	39	31	76	16	194	123	39	31	17
Ditsobotla	Ditsobotla	60905	Rustenburg NU	60905003	Rural	368	69 404	0.0	334	23	11	87	130	70	51	24	372	145	130	98	23
Ditsobotla	Ga-Raphalane	60906	Bodibe	60906001	Rural	4 798	2 645	1.8	4 585	182	31	67	333	743	157	3175	1513	4075	333	98	182
Ditsobotla	Itekeng	60907	NONE	60907000	Rural	549	36	15.4	524	25	0	0	532	0	4	0	561	4	532	0	25
Ditsobotla	Itsoseng	60908	Itsoseng 1	60908001	Rural	2 190	304	7.2	2 004	168	18	666	1506	0	3	0	2361	3	1506	684	168
Ditsobotla	Itsoseng	60908	Itsoseng 2	60908002	Rural	751	170	4.4	495	245	11	571	173	0	7	0	1007	7	173	582	245
Ditsobotla	Itsoseng	60908	Itsoseng 3	60908003	Rural	2 854	292	9.8	2 182	631	41	2267	375	10	198	3	3522	211	375	2308	631
Ditsobotla	Kopano	60909	Sheila	60909001	Rural	303	253	1.2	284	19	0	9	117	177	3	0	325	180	117	9	19
Ditsobotla	Kopano	60909	Verdwaal	60909002	Rural	1 283	364	3.5	1 247	28	8	102	317	258	330	179	1043	767	317	110	28
Ditsobotla	Kopano	60909	Welverdiend	60909003	Rural	147	63	2.3	140	7	0	4	32	31	83	0	157	114	32	4	7

Municipality	Main Place	Main Place Code	Sub-Place Name	Sub-Place Code	Rural/ Urban [1996]	Total	Area [ha]	HH Density [hh/ha]	Low Income [0-R38 000 pa]	Medium Income [R38 000 to R153 000 pa]	High Income [R153 000 and above]	Piped water inside dwelling	Piped water inside yard	Communal SP < 200 m	Communal SP > 200 m	Borehole	Unimproved	No Service (Below RDP)	Dry	Intermediate	Waterborne
Ditsobotla	Lichtenburg	60910	NONE	60910000	Urban	1 624	8 157	0.2	790	604	230	1276	253	40	48	5	2451	93	253	1506	604
Ditsobotla	Lichtenburg	60910	Blydeville	60910001	Rural	323	85	3.8	253	65	5	316	7	0	0	0	393	0	7	321	65
Ditsobotla	Lichtenburg	60910	Burgersdorp	60910002	Urban	1 167	376	3.1	529	478	160	768	282	61	49	0	1798	110	282	928	478
Ditsobotla	Lichtenburg	60910	Burgersdorp Ext 4	60910003	Rural	136	99	1.4	50	71	15	118	15	0	3	0	222	3	15	133	71
Ditsobotla	Lichtenburg	60910	Shukran	60910004	Urban	106	32	3.4	58	26	22	84	16	3	0	0	151	3	16	106	26
Ditsobotla	Mosiane	60911	Matile	60911001	Rural	269	174	1.5	266	0	3	0	63	62	101	14	229	177	63	3	0
Ditsobotla	Tlhabologang	60912	NONE	60912000	Rural	1 220	64	19.2	1 146	69	5	20	1099	68	28	0	1289	96	1099	25	69

Inputs to the cost model are based upon figures provided in the *"Municipal Infrastructure – An Industry Guide to Infrastructure Service Delivery Levels and Unit Costs",* more commonly known as the *Industry Guide*. In some cases the figures provided in the guide do not accurately reflect reality and input from "*Cost Benchmarks – Typical Unit Costs for Water Services Development Projects, a Guide for Local Authorities*", as developed by DWAF, reference date 2003, was used. This report complemented experience in other municipalities particularly that in the City of Johannesburg and Merafong City.

All costs have been escalated to 2011 costs and prices. Owing to a lack of a systematic benchmark for water services infrastructure costs, this escalation is an estimate.

The costing tables used in the model are the average costs for:

- reticulation for the different levels of service in the North West Province;
- storage reservoirs;
- bulk water supply schemes;
- borehole sources, diesel and electrical;
- water treatment works of various sizes;
- metered household connections in the North West Province;
- the different sanitation options at end-user level;
- the bulk sanitation outfall provision; and
- waste water treatment works of various sizes.

Water services infrastructure and background information are required to run the model for the local municipality. The information required in this category is the following:

- The availability of raw water treatment or waste water treatment facilities in the sub-place (and within varying distances);
- A measure of water availability which is the basic needs reserve for the sub-places, based upon a per household figure for the water management area in question. This figure is obtained from the Internal Strategic Perspective for the catchment and is a valid proxy for available water if there are no catchment transfer schemes in the study area. This figure is used to raise the water availability flag; and
- Water-using land uses in the area – this information needs to be gathered in the light of the potential for conflicting land uses in the area where the basic level is to be raised.

The model output provides raw costs based on the above inputs. Costs are provided per infrastructure component and these are:

- Internal Reticulation;
- Storage;
- Water Pipelines – bulk;
- Boreholes;
- Water Treatment Works;
- Metering;
- Management;
- Household Sanitation;
- Sewer Pipelines – bulk; and

- Sewerage Treatment Works.

The costs are based upon the following structure:

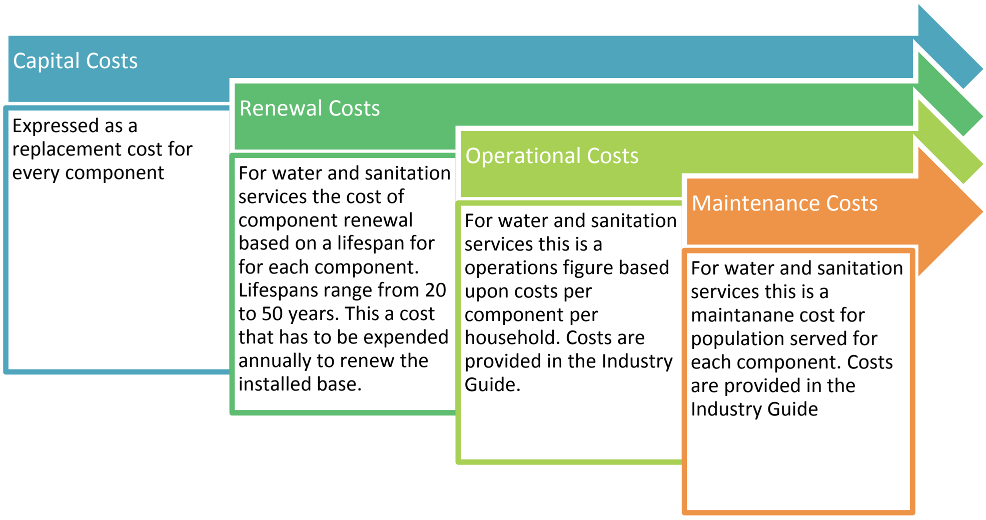


Figure 6: Cost Component Definitions

The raw costs thus obtained from the calculations made above are summarised as an estimated tariff. This estimated tariff is based upon the required "Return on Assets" plus the "Estimated Depreciation on Assets". This resultant tariff represents the midpoint tariff over a typically 25 year span required to generate a return on the assets and to replace the assets. This tariff is notional and is not the tariff that is changed to consumers. Adjustments to the resultant consumer tariff would take into account the different funding sources and the tariff adjustments over the lifespan of the assets.

The model generates costs based on each infrastructure component, thus changes in the level of service generate changing costs in the various components. These changes highlight important conclusions with regards to infrastructure components that would need to be upgraded first in any scheme of service improvement.

The model also provides estimates of the human resources required for each level of service change. This is done by estimating the human resources required for the existing level of service and subtracting that from the human resources needed for the required level of service. Thus additional human resources are broken down per infrastructure component, not per skill level. The human resources requirements are based on the benchmark report "*Development of Suitable Personnel Benchmarks for DWAF Owned Water Services Infrastructure*" as developed by DWAF in 2003 during the transfer of infrastructure to appropriate institutions.

The model then analyses the results, by reflecting the required additional budgets and human resources requirements as percentages of the original infrastructure. It also estimated the additional water demand and the extra "demand" for sewerage capacity.

The model does not attempt to reflect changes in water flows that will have influences on the built environment in the event of changes to the level of service. These influences are captured qualitatively in the discussion on the results of the modelling. These qualitative issues are based upon the findings of the literature review and upon internal discussions by the modelling team. The relevant qualitative issues are as follows:

- Return flows expressed as a percentage of the raw water used in the study area. In a rural area the return flows will comprise mainly of sanitation flows, with the relatively low volumes of grey water being disposed of locally. Thus, in rural areas, return flows are not applicable unless there is waterborne sanitation in the area. In urban areas, return flows comprise both sanitation flows as well as grey water flows. The basic figure used for return flows is as recommended in the Guidelines for Human Settlement Planning and Design, which is 750 litres per dwelling unit per day. This is for a highly developed urban area that enjoys high water availability and whose residents generally have access to both water and sanitation services. This figure will reduce to zero for rural areas with no sanitation and communal standpipes. The cost generated by the model depends upon the existing infrastructure in the area, but in principle, as the level of service increases return flows would have to be catered for and generate additional costs through the need for bulk outfall sewers and waste water treatments works;
- Grey water flows expressed as a percentage of the raw water used in the study area. This figure is applicable only for rural areas and covers the disposal of water from washing, cooking and spillage at the discharge points. In rural areas, if there is a possibility of grey water being generated, then the costing in the model will allow for soakaways at household level, forming part of the dry sanitation system;
- Wastage and leaks have an influence on the tariff recovered from consumers, which in turn influences the funds that can be made available for operations and maintenance and capital expenditure;
- The costs for the installation of metered connections at every household has been included in the model;
- Institutional costs have not been included in the model. For water services, the maintenance and operational costs include the costs for management, professionals and technicians, as well as plant, fuel and equipment costs. The same applies for the sanitation costs derived from the industry guide. These costs do not take into account the costs associated with setting up and running the necessary services institutions – the managerial and planning capacity, the accounting and financial capacity as well as costs associated with offices accommodation and the like;
- Environmental costs have not been factored into the model. A possible route towards factoring in environmental costs of sanitation could be by using nitrates as a pollution proxy. A figure of 4.5 gN/cap/day is used to estimate the pollution loads for the area if VIP toilets are used.

These aspects represent various flags which need to be considered by water services planners.

6.2. Analysis of findings

The model was run for various scenarios for the Ditsobotla Local Municipality and an analysis of the findings will be presented in this section.

6.2.1. Status Quo

The Status Quo scenarios modelled for this local municipality are laid out in the Table below. This information is based upon the Census 2001 dataset and will have changed in the interim. Hence the Status Quo reflects the situation as it was in 2001.

Table 25: Details of the Status Quo Level of Service for the Ditsobotla Local Municipality

Main Place	Sub Place	Rural/Urban	House Hold	Current Level of Service			
				Water	Equivalent Sewer	Water source	Meters
Bakwena Ba GaSerobatse	Ga-Motlatla	Rural	400	Yard Taps	Dry	Borehole (Electrical)	Not metered
Banogeng	Matile	Rural	105	No Service	No Service	Borehole (Diesel)	Not metered
Boikhutso	NONE	Rural	3014	Yard Taps	Dry	Borehole (Diesel)	Not metered
Boikhutso	Boikhutso	Rural	953	Standpipe & Communal taps	Dry	Borehole (Electrical)	Not metered
Coligny	NONE	Urban	1676	House Connections	House Connections	Borehole (Electrical)	Domestic meters
Ditsobotla	Lichtenburg NU	Rural	11122	Yard Taps	Dry	Borehole (Electrical)	Not metered
Ditsobotla	Madikwe NU	Rural	218	Standpipe & Communal taps	Dry	Water treatment Works	Not metered
Ditsobotla	Rustenburg NU	Rural	368	Yard Taps	Dry	Water treatment Works	Not metered
Ga-Raphalane	Bodibe	Rural	4798	No Service	No Service	Borehole (Diesel)	Not metered
Itekeng	NONE	Rural	549	Yard Taps	Dry	Borehole (Electrical)	Not metered
Itsoseng	Itsoseng 1	Rural	2190	Yard Taps	Dry	Borehole (Electrical)	Not metered
Itsoseng	Itsoseng 2	Rural	751	House Connections	House Connections	Water treatment Works	Domestic meters
Itsoseng	Itsoseng 3	Rural	2854	House Connections	House Connections	Borehole (Electrical)	Domestic meters
Kopano	Sheila	Rural	303	Standpipe & Communal taps	Dry	Borehole (Electrical)	Not metered
Kopano	Verdwaal	Rural	1283	Yard Taps	Dry	Borehole (Electrical)	Not metered
Kopano	Welverdiend	Rural	147	Standpipe & Communal taps	Dry	Borehole (Electrical)	Not metered
Lichtenburg	NONE	Urban	1624	House Connections	House Connections	Borehole (Electrical)	Domestic meters
Lichtenburg	Blydeville	Rural	323	House Connections	House Connections	Borehole (Electrical)	Domestic meters
Lichtenburg	Burgersdorp	Urban	1167	House Connections	House Connections	Water treatment Works	Pre-paid meters
Lichtenburg	Burgersdorp Ext	Rural	136	House Connections	House	Water treatment	Pre-paid meters

Main Place	Sub Place	Rural/Urban	House Hold	Current Level of Service			
				Water	Equivalent Sewer	Water source	Meters
	4				Connections	Works	
Lichtenburg	Shukran	Urban	106	House Connections	House Connections	Water treatment Works	Pre-paid meters
Mosiane	Matile	Rural	269	Standpipe & Communal taps	Dry	Borehole (Electrical)	Not metered
Tlhabologang	NONE	Rural	1220	No Service	No Service	Water treatment Works	Not metered

6.2.2. Scenario 1: Bring all to a Basic Level

This scenario consists of two sub-scenarios – 1a and 1b.

Scenario 1a models the case if all residents of the local municipality are brought up to a minimum basic level of service. For water services, this level of service is standpipes within 200 m radius of the houses. For sanitation services, this scenario assumes that VIP latrines are the basic standard. Those households that have higher levels of service are left as they are. This scenario assumes that the existing water sources remains the same as the status quo and that metering also remains the same as the status quo.

This scenario will impact upon 6 123 households out of a total of 35 576 households (17%) for the water and sanitation services. It should be noted that the per household results described below are calculated on the entire number of households in the municipality. This implies that the costs of provision of the additional levels of service have been spread over the entire community.

The results of the scenario are presented in the Table below:

Table 26: Scenario 1a Results

	Percentage Differences – Scenario 1a						
Assets	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	No. staff (high)	No. staff (low)	Total cost (R/annum)
Internal reticulation	6%	6%	6%	9%	-	-	8%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-	-	-	-	-	-	-
Water Treatment Works	-	-	-	-	-	-	-
Metering	-	-	-	-	-	-	-
Management	-	-	-	-	-	-	-
Household sanitation	16%	16%	17%	-	25%	24%	12%
Sewer pipelines (bulk)	-	-	-	-	-	-	-
Sewage Treatment Works	-	-	-	-	-	-	-
Total	11%	11%	9%	7%	6%	6%	8%

The model shows that the financial implications for the municipality would be an 8% increase in the total annual cost of the internal water reticulation network and a 31% increase in the total annual costs of the bulk water supply network. Hence the major costs and programme management would be in improving the bulk water supplies to the consumers impacted upon by the improvement of the level of service.

The financial implications of the improvement of the sanitation level of service for those having no service to supplying these households with dry sanitation in the form of VIP latrines, will be a 12% increase in the annual costs of the sanitation service.

In terms of human resources implications, the number of personnel of all grades would increase by 25% to cater for the increased number of VIP latrines in the municipality. There would be no increase in the number of personnel required for the water services, owing to the basic nature of the water service level of improvement.

For Scenario 1a, the major additional infrastructure costs are located in the provision of household sanitation, which requires an additional R582/household in capital costs (an increase of 14%) and an additional R62/household/annum in renewal and maintenance costs. The next highest cost would be the provision of bulk water supply pipelines, R307/household in capital costs (an increase of 25%) and an additional R6/household/annum in renewal costs. The provision of additional internal reticulation would be R282/household in capital costs (an increase of 8%) and an additional R41/household/annum in renewal and maintenance costs. Additional operations costs would add up to R96/household/annum. Additional overall staffing increases would be 22 people at all skills levels,

Overall, this option would require an additional monthly household contribution of R114.83, approximately half of this figure would be for the provision of basic sanitation services, the remainder divided between bulk supply and water reticulation.

Scenario 1a and 1b both yield an average household consumption figure of 14 000l/hh/month. This is the community average, taking into account the households with higher levels of service. Thus the average is higher than the 7 000l/hh/month that the model indicates for those households that have standpipe and communal water supplies. The average return flows from sewerage use in the community is 5 000l/hh/month, similarly this is the average for the entire community.

Scenario 1b models the case if all residents of the local municipality are brought up to a minimum basic level of service, but the water supply has been upgraded to include only treated water. In other words, if the existing supply system includes an unimproved source, this source is assumed to be removed and replaced with water from a raw water treatment works. For water services, this level of service is standpipes within 200 m radius of the houses. For sanitation services, this scenario assumes that VIP latrines are the basic standard. Those households that have higher levels of service are left as they are. This scenario assumes that all the water sources for the municipality are from a water treatment works and that all water is treated. Metering remains the same as the status quo.

This scenario will impact directly upon 6 123 households out of a total of 35 576 households (17%) for the water and sanitation services. The improvement to the water treatment aspect of the scenario will impact upon 31 610 households – some 89% of the households in the municipality.

The results of the scenario are presented in the table below:

Table 27: Scenario 1b Results

	Percentage Differences – Scenario 1b						
Assets	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	Number Of staff (high)	Number Of staff (low)	Total cost (R/annum)
Internal reticulation	6%	6%	6%	9%	-	-	8%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Water Treatment Works	808%	808%	819%	678%	350%	220%	720%
Metering	-	-	-	-	-	-	-
Management	-	-	-	-	-	-	-
Household sanitation	16%	16%	17%	-	25%	24%	12%
Sewer pipelines (bulk)	-	-	-	-	-	-	-
Sewage Treatment Works	-	-	-	-	8%	9%	-
Total	13%	12%	9%	10%	9%	8%	10%

The model shows that the financial implications for the municipality would be an 8% increase in the total annual cost of the internal water reticulation network and a 31% increase in the total annual costs of the bulk water supply network. These results are the same as those for scenario 1a, as expected. A similar result is shown for the sanitation aspect of the scenario.

Since most of the water supply for the local municipality was from borehole sources, the conversion to all treated water means that all the boreholes would have to be decommissioned and the human resources used to maintain then re-directed to maintenance of other aspects of the water supply system.

As expected, the major financial input required for this scenario is the improvement of the water treatment system. The total costs of this system are 720% higher than the current water treatment system. The current water treatment system serves 3 966 households, which is 11% of the total households in the municipality. Thus serving the remaining 89% of households in the municipality increases the cost for water treatment works by 720%. Similar increases for the human resources required to operate the new infrastructure are expected – the range of personnel increases is between 220% and 350% – a large increase to be absorbed into the existing water services institutions.

For Scenario 1b, the major additional infrastructure costs are the same as Scenario 1a, except that the additional costs of water treatments works provision is to be added. In this regard, this requires an additional R297/household in capital costs (an increase of 700%) and an additional R16/household/annum in renewal and maintenance costs. Operational costs would account for a further R29/household/annum. Additional overall staffing increases would be 43 people at all skills levels for the complete scenario and an additional 11 people for the additional water treatment works.

Overall, this option would require an additional monthly household contribution of R143.34, approximately one third of this figure would be for the provision of basic sanitation services, the remainder divided, almost equally, between water treatment works, bulk supply and water reticulation. Water reticulation is the smallest of the remaining three portions.

6.2.3. Scenario 2: Yard Connections, Basic Sanitation

This scenario consists of three sub-scenarios – 2a, 2b and 2c.

Scenario 2a models the case if all residents of the local municipality are brought up to a yard connection level of water services. For sanitation services, this scenario assumes that VIP latrines are the minimum standard. Those households that have higher levels of service are left as they are. This Scenario assumes that the existing water sources remains the same as the status quo and that metering also remains the same as the status quo.

This Scenario will impact upon 9 689 households out of a total of 35 576 households (27%) for the water services and upon 6 123 households out of a total of 35 576 households (17%) for the sanitation services. It should be noted that the per household results described below are calculated upon the whole number of households in the municipality. This implies that the costs of provision of the additional levels of service have been spread over the entire community.

The results of the Scenario are presented in the Table below:

Table 28: Scenario 2a Results

	Percentage Differences – Scenario 2a						
Assets	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	Number Of staff (high)	Number Of staff (low)	Total cost (R/annum)
Internal reticulation	23%	23%	23%	16%	-	-	18%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-	-	-	-	-	-	-
Water Treatment Works	-	-	-	-	-	-	-
Metering	-	-	-	-	-	-	-
Management	-	-	-	-	-	-	-
Household sanitation	16%	16%	17%	-	25%	24%	12%
Sewer pipelines (bulk)	-	-	-	-	-	-	-
Sewage Treatment Works	-	-	-	-	-	-	-
Total	16%	16%	20%	14%	6%	6%	16%

The model shows that the financial implications for the municipality would be an 18% increase in the total annual cost of the internal water reticulation network and a 31% increase in the total annual costs of the bulk water supply network.

This result, taken with the results on Scenario 1a, shows that internal reticulation costs increase more rapidly when a two-step jump is made in the water level of service. However, the increase in expenditure is not proportional to the increase in households served. For an

18% increase in the internal reticulation costs, 6 123 (17%) households make a two-step jump, whilst the remaining 3 566 (10%) people make a one-step jump to yard connections.

The increase in bulk costs, of 31%, is the same as the increase required for the more limited level of water services – that of communal standpipes. This demonstrates that the bulk water spending increases are relatively insensitive to the eventual level of service enjoyed by the downstream households. This conclusion, so far, holds true for all service levels below house connections.

The sanitation result mirrors that of the Scenario 1a.

For Scenario 2a, the major additional infrastructure costs are located in the provision of internal reticulation, which requires an additional R786/household in capital costs (an increase of 19%) and an additional R115/household/annum in renewal and maintenance costs. These costs are supplemented by an additional R167/household/annum. The next highest cost would be the provision of sanitation services, R582/household in capital costs (an increase of 14%) and an additional R63/household/annum in renewal and maintenance costs. The provision of additional internal reticulation would cost R307/household in capital costs (an increase of 25%) and an additional R6/household/annum in renewal costs. Additional overall staffing increases would be 22 people at all skills levels,

Overall, this option would require an additional monthly household contribution of R168.91, approximately 50% going towards to internal reticulation, then towards the provision of basic sanitation services, the remaining 20% being internal water reticulation.

Scenario 2a and 2b both yield an average household consumption figure of 15 000l/hh/month. This is the community average, taking into account the households with higher levels of service. Thus the average is higher than the 11 000l/hh/month that the model indicates for those households that have yard connections. The sewerage return flows in the community is 5 000l/hh/month, similarly this is the average for the entire community.

Scenario 2b models the case if all residents of the local municipality are brought up to a yard connection level of water services, but the water supply has been upgraded to include only treated water. For sanitation services, this scenario assumes that VIP latrines are the basic standard. Those households that have higher levels of service are left as they are. This scenario assumes that all the water sources for the municipality are from a water treatment works and that all water is treated. Metering remains the same as the status quo

This scenario will impact upon 9 689 households out of a total of 35 576 households (27%) for the water aspect of the scenario and upon 6 123 households out of a total of 35 576 households (17%) for the sanitation services aspects of the scenario. The increase in households receiving treated water total is 31 610 households – some 89% of the households in the municipality.

The results of the scenario are presented in the Table below:

Table 29: Scenario 2b Results

	Percentage Differences – Scenario 2b						
Assets	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	Number Of staff (high)	Number Of staff (low)	Total cost (R/annum)
Internal reticulation	23%	23%	23%	16%	-	-	18%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Water Treatment Works	808%	808%	819%	678%	350%	220%	720%
Metering	-	-	-	-	-	-	-
Management	-	-	-	-	-	-	-
Household sanitation	16%	16%	17%	-	25%	24%	12%
Sewer pipelines (bulk)	-	-	-	-	-	-	-
Sewage Treatment Works	-	-	-	-	-	-	-
Total	18%	17%	20%	16%	9%	8%	17%

The model results mirror the results from scenario 2a and scenario 1b.

In total, the annual expenditure for the municipality increases by 19% to effect these changes in the water services situation. This result is achieved despite the dramatic increase in the water treatment works expenditure. The model demonstrates the conclusion that the major costs for the total water services system are not contained in the water treatment works. The list below provides the relative values of the infrastructure in the local municipality:

1. Household sanitation 34.2%
2. Internal reticulation 33.7%
3. Water pipelines (bulk) 9.9%
4. Sewage Treatment Works 7.5%
5. Elevated storage 5.4%
6. Metering 4.9%
7. Water Treatment Works 2.7%
8. Sewer pipelines (bulk) 1.2%
9. Boreholes 0.6%

For Scenario 2b, the major additional infrastructure costs are the same as Scenario 2a. The additional sanitation costs mirror those of Scenario 1b. Overall, this option would require an additional monthly household contribution of R197.42.

Scenario 2c uses the same assumptions as that for scenario 2b, but that all of the yard connections are individually metered. This scenario will impact upon 9 689 households out of a total count of 35 576 households (27%) for the water aspect of the scenario.

The results of the Scenario are presented in the Table below:

Table 30: Scenario 2c Results

Assets	Percentage Differences – Scenario 2c						
	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	Number Of staff (high)	Number Of staff (low)	Total cost (R/annum)
Internal reticulation	23%	23%	23%	16%	-	-	18%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Water Treatment Works	808%	808%	819%	678%	350%	220%	720%
Metering	296%	296%	239%	288%	-	-	282%
Management	-	-	-	-	-	-	-
Household sanitation	16%	16%	17%	-	25%	24%	12%
Sewer pipelines (bulk)	-	-	-	-	-	-	-
Sewage Treatment Works	-	-	-	-	-	-	-
Total	35%	35%	25%	16%	9%	8%	22%

The model results mirror the results from scenario 2a, 2b and scenario 1b. The Scenario demonstrates that the metering costs are substantial, a conclusion mirrored in those for Scenario 2b. Overall, this option would require an additional monthly household contribution of R358.40.

6.2.4. Scenario 3: House Connections, Full Sanitation

This scenario consists of three sub-scenarios – 3a, 3b and 3c.

Scenario 3a models the case if all residents of the local municipality are brought up to a house connection level of water service. For sanitation services, this Scenario assumes that all sanitation is connected in-house and is waterborne. This Scenario assumes that the existing water sources remain the same as the status quo and that metering also remains the same as the status quo.

This Scenario will impact upon 26 939 households out of a total of 35 576 households (76%) for the water and sanitation services. It should be noted that the per household results described below are calculated on the entire number of households in the municipality. This implies that the costs of provision of the additional levels of service have been spread over the entire community.

The results of the Scenario are presented in the Table below:

Table 31: Scenario 3a Results

	Percentage Differences – Scenario 3a						
Assets	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	Number Of staff (high)	Number Of staff (low)	Total cost (R/annum)
Internal reticulation	66%	66%	66%	118%	-	-	100%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-	-	-	-	-	-	-
Water Treatment Works	-	-	-	-	-	-	-
Metering	-	-	-	-	-	-	-
Management	-	-	-	-	-	-	-
Household sanitation	89%	89%	78%	312%	25%	24%	137%
Sewer pipelines (bulk)	394%	394%	373%	210%	287%	283%	364%
Sewage Treatment Works	312%	312%	312%	312%	191%	191%	312%
Total	89%	82%	71%	144%	118%	126%	113%

For this Scenario, municipal annual spending on water and sanitation services increases by 113%. This is largely due to the large increases for internal water reticulation and for household level sanitation connections; these large-cost items increased by 100% and 137% respectively.

Other large-cost items largely involve sanitation. Spending on bulk sewer pipelines and waste water treatment works increased by 364% and 312% respectively.

The relative proportions of the costs for this Scenario on the various infrastructure components are as follows:

1. Household sanitation 35.5%
2. Internal reticulation 28.4%
3. Sewage Treatment Works 19.4%
4. Water pipelines (bulk) 6.1%
5. Sewer pipelines (bulk) 3.6%
6. Elevated storage 3.4%
7. Metering* 3.0%
8. Boreholes 0.4%
9. Water Treatment Works* 0.2%

* Scenario 3a excludes upgrading these items, so these figures are un-representative

Again, this Scenario highlights the considerable spending required at the household level for the higher levels of service. The Scenarios presented thus far have supported the conclusion that for small increases in the level of service, the costs are weighted towards the bulk aspects of the water services system. As the levels of service improve towards full house connections and waterborne sanitation systems, the spending required shifts back to household level infrastructure. It thus implies that design and efficiency improvements at this level will yield the greatest savings when done at a household reticulation level.

Matching the increase in municipal spending is an approximate increasing by 35% of the number of staff required to service the new infrastructure. This includes staff at all technical levels, including engineers.

Scenarios 3a, 3b and 3c all yield an average household consumption figure of 34 000l/hh/month. This is the community average, taking into account the households with higher levels of service. Thus the average is higher than the 11 000l/hh/month that the model indicates for those households that have standpipe and communal water supplies. The average sewerage return flows in the community is 5 000l/hh/month, similarly this is the average for the entire community.

Scenario 3b models the case if all residents of the local municipality are brought up to a house connection level of water service, all water sources are improved, and that sanitation services are fully waterborne. In addition, this Scenario assumes that all the water sources for the municipality are from a water treatment works and that all water is treated. Metering remains the same as the status quo

This scenario will impact upon 26 939 households out of a total of 35 576 households (76%) for the household level water and sanitation services. The increase in households receiving treated water total some 31 610 households – some 89% of the households in the municipality.

The results of the Scenario are presented in the Table below:

Table 32: Scenario 3b Results

	Percentage Differences – Scenario 3b						
Assets	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	Number Of staff (high)	Number Of staff (low)	Total cost (R/annum)
Internal reticulation	66%	66%	66%	118%	-	-	100%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Water Treatment Works	808%	808%	819%	678%	350%	220%	720%
Metering	-	-	-	-	-	-	-
Management	-	-	-	-	-	-	-
Household sanitation	89%	89%	78%	312%	25%	24%	137%
Sewer pipelines (bulk)	394%	394%	373%	210%	287%	283%	364%
Sewage Treatment Works	312%	312%	312%	312%	191%	191%	312%
Total	91%	83%	71%	147%	122%	128%	115%

This Scenario demonstrates that the increase in spending for the full water treatment option is not large, with total annual spending increasing from 113% to 115%. This two percent increase highlights the fact that water treatment works on this small scale are not a major cost component, when compared to the spending required to improve household level infrastructure.

Human resources increases are higher than Scenario 3a, since the addition of treatment works requires relatively more staff than an expansion of the household level infrastructure requires.

Scenario 3c models the case when each household connection is individually metered.

The results of the Scenario are presented in the Table below:

Table 33: Scenario 3c Results

	Percentage Differences – Scenario 3c						
Assets	Estimated replacement cost (R)	Estimated renewal cost (R/annum)	Estimated maintenance cost (R/annum)	Estimated operating cost (R/annum)	Number Of staff (high)	Number of staff (low)	Total cost (R/annum)
Internal reticulation	66%	66%	66%	118%	-	-	100%
Elevated storage	-	-	-	-	-	-	-
Water pipelines (bulk)	33%	33%	15%	20%	-	-	31%
Boreholes	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Water Treatment Works	808%	808%	819%	678%	350%	220%	720%
Metering	300%	300%	254%	292%	-	-	289%
Management	-	-	-	-	-	-	-
Household sanitation	89%	89%	78%	312%	25%	24%	137%
Sewer pipelines (bulk)	394%	394%	373%	210%	287%	283%	364%
Sewage Treatment Works	312%	312%	312%	312%	191%	191%	312%
Total	108%	101%	76%	147%	122%	128%	120%

In this Scenario, the annual spending increases by 5% over and above Scenario 2b, which does not allow for meters. This result again demonstrates the high costs of water meters, which are required to account for all water accurately and to develop an equitable billing system.

The model does not allow for operational staff for the reading of the meters and this increase in human resources is a hidden cost that should be factored into planning for higher levels of water services.

6.2.5. Overall Model Results

The series of Tables and Graphs below provide overall model details. These results are presented as a summary of the model outputs and are less aggregated than the detailed outputs described in the previous three sections.

The Table below summarises the main findings of the model.

Table 34: Tabular Summary of Findings for all Scenarios

Scenario	Description	Water Supply Level [kl/hh/month]	Additional Staff	Additional Capital/ Household [R/hh]	Additional Monthly Costs [R/hh/month]
1a	All households with RDP connection, dry sanitation	14	32	1 171.17	21.13
1b	All households with RDP connection, water treatment works source, dry sanitation	14	43	1 468.20	25.88
2a	All households with yard connection, dry sanitation	15	22	1 674.99	34.91
2b	All households with yard connection, water treatment works source, dry sanitation	15	43	1 972.02	39.65
2c	All households with yard connection, water treatment works source and domestic meters, dry sanitation	15	43	3 786.92	54.84
3a	All households with house connection, waterborne sanitation	34	467	9 544.73	246.28
3b	All households with house connection, water treatment works source, waterborne sanitation	34	488	9 841.77	251.05
3c	All households with house connection, water treatment works source and domestic meters, waterborne sanitation	34	488	11 656.67	266.84

The results of this Table are shown graphically below.

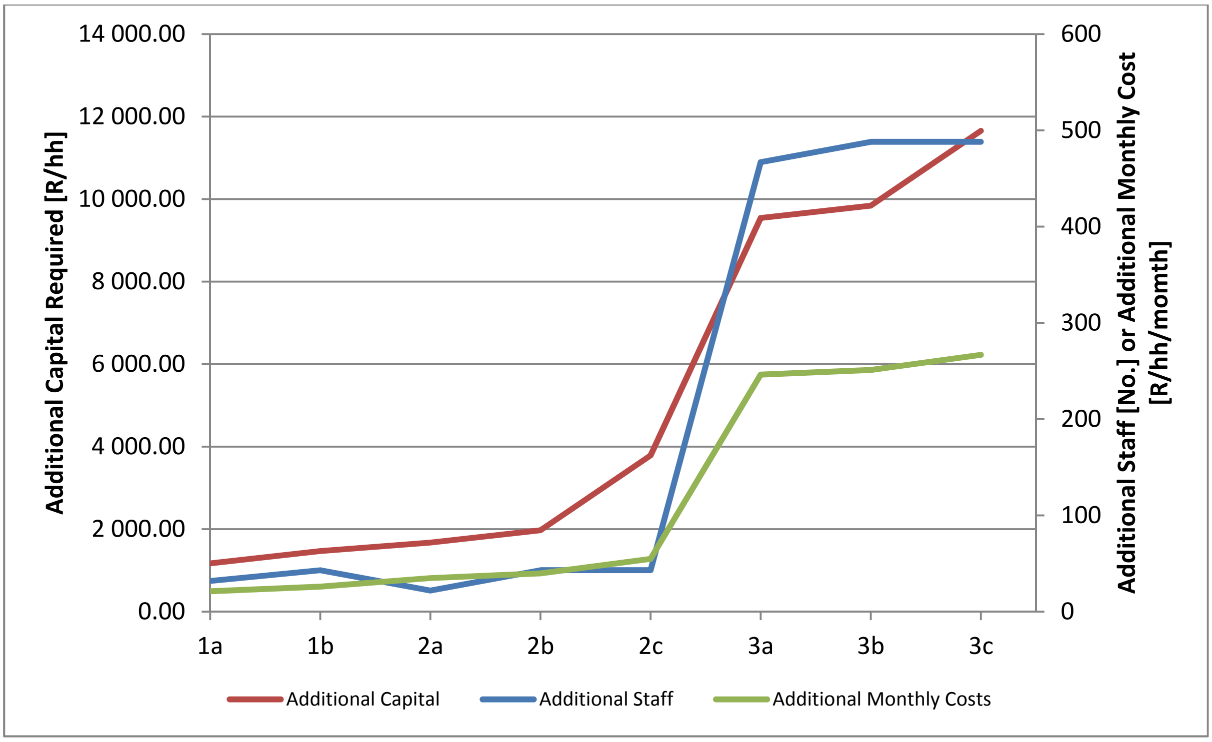


Figure 7: Graphical Summary of Findings for all Scenarios

The main conclusions to be drawn from this data are as follows:

1. Increasing the level of service to a yard level water supply with dry sanitation is the last step, which does not carry with it serious cost implications. Once the decision has been taken to upgrade to household connections, the costs and human resources requirements jump substantially. The model demonstrates that the per household cost implication is an increase of 2.5 times, with human resources requirements being 10 times higher;
2. Metering is a major cost driver. The costs of metering can be seen in the increases between the "b" and the "c" Scenarios. Metering is required to control water consumption and to recover the costs of supply. Without metering water supply will be financially and water resource-wise unsustainable. However the decision to install meters is one that contains cost implications. The cost implication of meters on a full service level scenario is to add 18% to the overall value of the infrastructure. If a similar decision is taken at the yard level of supply, the cost of metering will double the average cost per household. This result is understandable given that the installation of meters at the DLM level is not very far advanced. Since meter installation affects a high percentage of the population, the community wide cost per household of the meters will tend towards the unit costs of the meters;
3. For a full service to be provided to the entire community, a substantial increase in the notional costs per household, will take place. Funding of this burden would have to be canvassed with affected communities. It is not given that all communities would want to shoulder the burden for a full level of supply – hence community consultation would have to take place at a local level. A central Government decision taken in this regard would not necessarily be supported by all communities, hence the costs would tend to fall to the central Government.

4. The additional staff required to move towards a full level of service should be considered by policy makers. Although it is outside the scope of this study, evidence from the existing Blue Drop and Green Drop campaigns suggest that not all municipalities are endowed with sufficient technical skills to operate and maintain a large step in the level of water services. Hence the creation of the necessary skills is an important step for the movement to this higher level of service to be successful.

The Graph below presents the capital required to achieve each Scenario in more detail.

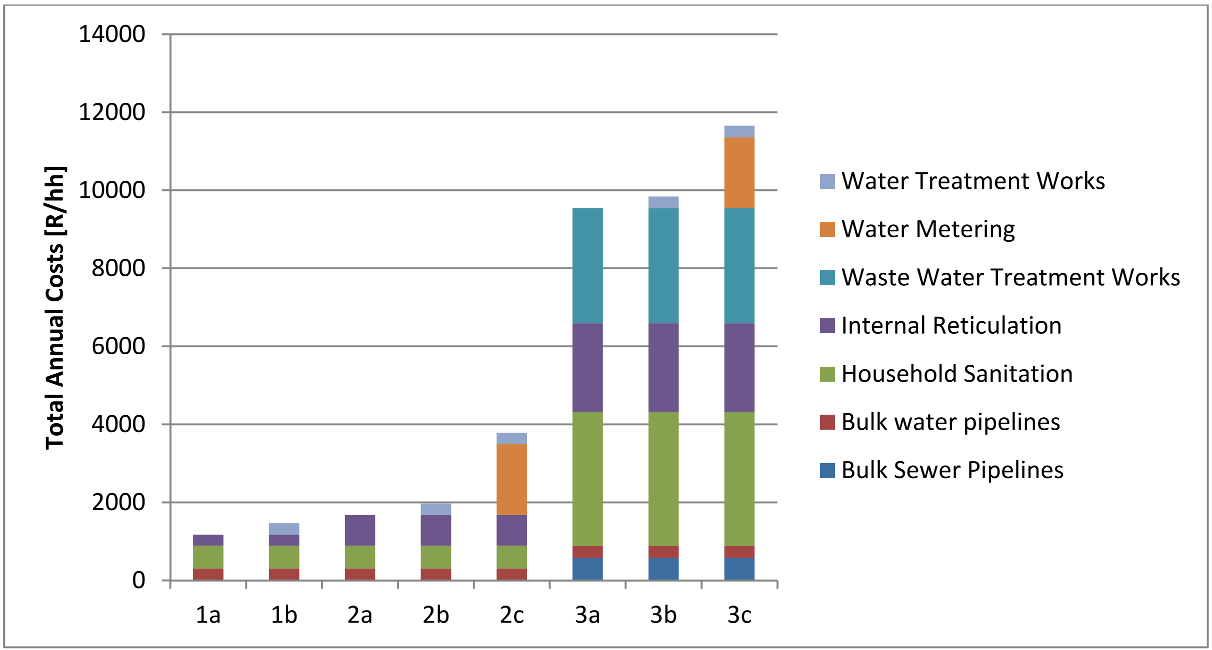


Figure 8: Additional Capital Required to Achieve Each Scenario

Household sanitation is a major component of the costing for the full level of service. This can be seen in Scenario 3, which was the first Scenario introduced by the model that included waterborne sanitation. Household sanitation for Scenario 2 is also a major proportion of the overall smaller costs for the provision of a yard connection level of service. The costs for sanitation are in this case mainly to provide for VIP latrines.

A further major component of the costing is the costs of internal water reticulation. This cost rises substantially at the full level of service, In this case, both larger and more reticulation pipes are needed to service any given community.

The construction of Waste Water Treatment works is a large expense at the full level of service. This cost is linked to the cost for sanitation at a household level, and reinforces the view that water supplies are far less capital intensive than full sanitation services.

The Graph below shows the additional annual costs of the various water service level scenarios. This Graph does not take into account the financial burden for the existing level of service.

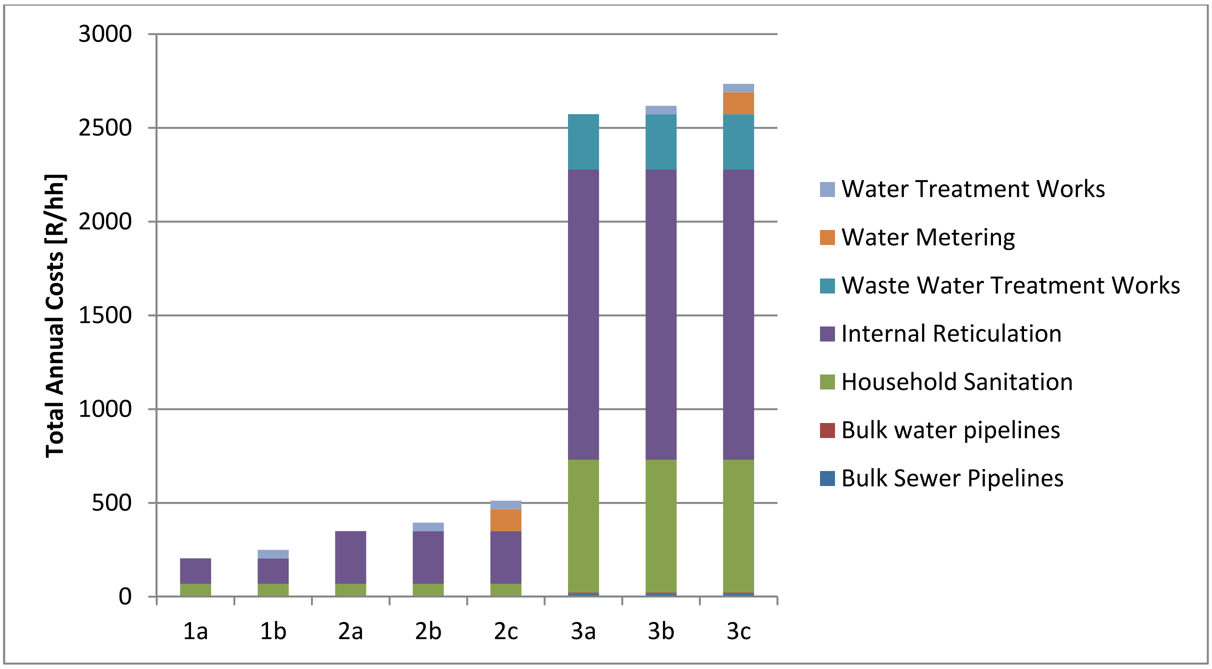


Figure 9: Additional Annual Operational Expenditure Required to Sustain Each Scenario

Additional annual costs include renewal costs (which is a depreciation-like cost to renew the infrastructure at the end of its life), maintenance costs (which is for on-going repair of the infrastructure) and operations costs (which are the human resources, supplies and materials that are required to keep the infrastructure working on a daily basis). These three costs have been added together to arrive at the total additional cost to achieve the given level of service, displayed in the Graph above.

In every scenario, the majority of the annual costs are spent on the water reticulation network. Reticulation networks, being a major capital component of any network, being spread over wide areas and complex in its operation, requires a large proportion of the funds necessary to operate and maintain a water services network.

Similarly, the household level sanitation system is the next largest on-going cost for the water services network.

Treatment work, both waste water and raw water, both require operations and maintenance costs. The model however demonstrates that the operation of waste water treatment works is a far more significant cost driver than that for raw water treatment works. This conclusion links with the findings above that sanitation services are more expensive to provide on a per capita basis than water services.

The total additional annual costs are the minimum that should be covered by users in order for the service to remain financially sustainable. In this context user funding could include some form of cross-subsidisation, or from indigent grants. For the full level of service, the model indicates that an annual household cost of R2 735 is possible. This works out to R228 per month. The equivalent figure for the yard level connection is R42.67 per household per month and for the standpipe/communal level of service the cost would be R20.83 per household per month.

If the repayment of capital items is included in the monthly costs, this figure could increase to R266 per household per month, if the infrastructure is to be re-paid over a 25 year period. The equivalent figure for the yard level connection is R54.84 per household per month and for the standpipe/communal level of service the cost would be R25.88 per household per month.

6.2.6. Flags arising from the model

In addition to the results from the model, the following flags are raised which provide implications for raising the basic level of water services. These flags are aspects that have not been directly captured in the model, but which provide additional depth to the findings on this study. These flags are taken from Scenario 3c.

The additional water demand represents additional annual demand of 6.5 million cubic meters. This equates to additional demand of 32.83 m^3/cap/year. Nationwide, the amount of water available per person is 205 m^3/cap/year (DWA, 2010). Thus the increase is acceptable when taken at a national scale. However, the amount of water available in the region of the Ditsobotla Local Municipality is lower than that on a national scale and thus this additional water use will place stress on the local water sources. Also to be noted is that the model does not make provision for fire protection, which is generally not taken into account in water services design in rural areas, but will be required once these areas urbanise.

The other flags are listed in the Table below.

Table 35: Flags Arising from the Modelling

Flag	Implication	Impact Upon?
Return Flows	Return flows are captured in the increased sewerage demand. Scenario 3c assumes that WWTW will be constructed locally where required and that all return flows will be processes by the WWTW. Return flow diversion strategies will decrease the demand for sewerage treatment, thereby improving capital replacement cycles and reducing operational costs	Mainly upon rural areas where treatment capacity does not have the advantage of scale.
Grey Water	Grey water issues are linked to sewerage treatment capacity. If grey water diversion strategies such as separate household plumbing and soakaways were to be introduced, sewerage demand would be decreased. This effort would also greatly assist in water conservation and demand management, which is essential in the DLM. However, any household level intervention requires heavy spending and this factor provides the counter-balance to implementing grey water diversion schemes. The model does not attempt to investigate this balance.	Mainly upon rural areas where treatment capacity does not have the advantage of scale.

Flag	Implication	Impact Upon?
Illegal Connections	Illegal connections always reduce the revenue arising from providing a water service. They also increase the maintenance costs of a system and serve to increase demand from the system since the user incurs no negative consequence from using limitless water. All of these factors reduce the sustainability of the system. In Scenario 2c and 3c, meters are allowed for. The cost of the meters is significant when planning water services schemes and provides a counter-balance to universal provision of meters. The model does not attempt to investigate this balance.	All aspects of the water system
Wastage/Leaks	Wastage can always reduce the revenue arising from providing a water service. It also increases the maintenance costs of a system. All of these factors reduce the sustainability of the system. The counter-balance is the costs of maintenance. The model does not attempt to investigate this balance, but with thorough design and implementation of good construction standards will reduce leaks at very minimal costs.	All aspects of the water system
Environmental	Environmental impacts such as increased pollution loads in rivers, increased use of scarce water resources and the management of run-off water are all environmental impacts of increasing the basic level of water services. Most of these impacts are currently managed through legislation and enforcement of standards. They are thus adequate. The environmental impact of undue stress on the local water resource is one that cannot be mitigated except by matching the level of service to meet the water resource availability. This is a fundamental constraint upon the universal raising of the basic level of service and would have to be investigated at scheme level	Scheme level
Affordability	Seventy-six percent of the households in the area earn below R19 200 per annum, with 18% earning no income at all. This raises an affordability red flag. If households cannot carry the costs of a higher level of service, the funds would have to be sourced from elsewhere. The allocation of this type of budgetary support is a social and political question that is not investigated in the current study.	All low income households
Human Resources	The model gives a benchmark estimate as to what the required number of additional staff will be required, it does not comment on the skill levels of each member of staff, not does it comment on the availability of the required staff. These education and training issues are central to the whole project.	Local Authority

6.2.7. Application of the Model to a National Scale

Following the development of the model for the DLM, the model was then applied on a national scale. Two applications of the model were carried out. The first application was the so-called “Roll-Up Method, the second was the so-called “Step Method”. The results of both methods are described below.

Roll-Up Method

The methodology applied was as follows. All of the sub-place data used in the Census 2001 was obtained and fields such as the population, number of households, area and a 2001 estimate of the level of service were obtained for each sub-place. This data was then re-analysed to make it compatible with the model. The information was rolled up to a district municipality level within each province. For each district municipality, the population, the number of households, the area and the average size of the sub-places were used in the final analysis. The analysis was then carried out to a provincial level.

The scenario that was modelled was to bring the population up to the full service level – house water connections from treated sources and water-borne sewerage. The households that enjoyed this level of service in 2001 are thus not affected in the model, but those with lower levels of service are added to the costs of providing the full level of service.

The results of the analysis are summarised in the Table below:

Table 36: National Cost and Manpower Implications – Roll-Up Method

	Status Quo: Estimated cost					Future Scenario: Estimated additional cost				
Province	Replacement (R million)	Renewal (R million /annum)	Maintenance (R million /annum)	Operating (R million /annum)	Avg Staff required	Capital (R million)	Renewal (R million /annum)	Maintenance (R million /annum)	Operating (R million /annum)	Avg Staff required
Eastern Cape	9 778	480	412	1 340	5 701	18 115	820	574	3 241	1 943
Free State	6 553	324	341	871	2 623	8 472	364	294	1 363	960
Gauteng	29 658	1 439	1 144	5 048	7 264	18 255	795	444	3 028	1 174
KwaZulu-Natal	17 679	863	654	2 646	8 228	20 387	914	655	3 685	2 915
Mpumalanga	5 792	290	264	794	2 821	8 473	368	290	1 436	1 160
North West	6 461	326	309	895	3 567	11 798	515	413	1 930	1 817
Northern Cape	2 828	133	151	364	1 159	1 697	72	59	265	733
Limpopo	7 657	388	350	876	4 663	14 467	640	453	2 707	1 845
Western Cape	16 639	782	686	2 964	4 045	5 524	244	123	611	812
South Africa	103 049	5 028	4 314	15 801	40 069	107 192	4 736	3 309	18 270	13 359

The model indicates that the costs for bringing the entire 2001 population up to a full level of service would be in the order of R110 billion. Once this infrastructure has been constructed, the annual costs of servicing and maintaining it would be in the order of R26 billion.

The annual operation costs were further analysed using the discounted cashflow method. This was used to arrive at a present day cost for the future maintenance. The discounted cashflow method assumes that the annual costs of R26 billion remain constant every year into the future. The method reduces future year costs by a discount rate to adjust for the fact that money to be spent in the future is worth less today. The method is very sensitive to the discount rate chosen. This is demonstrated in the graph below:

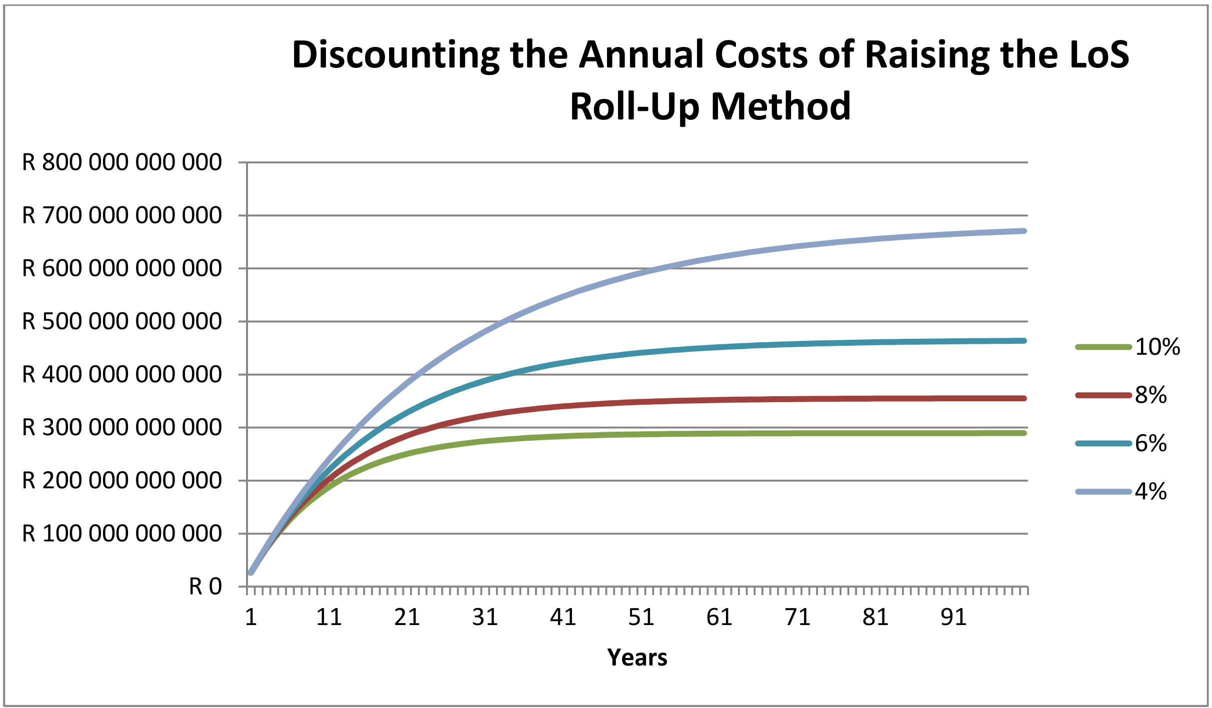


Figure 10: Discounting the National Level Cashflows – Roll-Up Method

The Graph shows how the discounted costs taper off for every discount level as the number of years into the future exceeds approximately 30 years. If the discount rate is the country's inflation rate, it shows how a low inflation rate increases the future costs of maintenance. The Graph also shows that the present value of the annual costs is more than double the initial capital requirement. Thus, marginally higher capital expenditure to achieve operations and maintenance expenditure reduction, will be recouped relatively quickly.

If a discount rate of 10% is chosen the present value of the annual operations costs for the next 25 years will be R265 billion. The similar costs, using an 8% discount rate would be R307 billion. These costs should be added to the capital cost to arrive at a total figure for the present day estimate of the cost of bringing all of the population up to a full water-borne level of service.

The model also demonstrates that an additional 11 000 water services personnel would have to be employed countrywide. These are annual type positions and do not account for the positions created during the construction phase of the national roll-out.

The model makes the following assumptions in arriving at these figures. These assumptions and their implications are listed below:

1. The process of rolling up the data results in a large degree of simplification. The sub-place sizes that are to be served are averaged and, the population sizes and household densities are averaged. This process of averaging is expected to smooth out the peaks and the troughs in the data. This means that the areas that will be cheaper to service would be averaged out and the areas that are very expensive to service would also be averaged out. Given that that scope for cost savings is always less than the scope for cost increases, it leads to the conclusion that these cost estimates are optimistic, i.e. lower than the actual final cost;
2. This analysis is done using the 2001 water supply situation. Since 2001 a great deal of work has been done to improve the average level of water service, thus a greater percentage of the population would be at higher levels of service in 2011 than in 2001. The model ignores all of this previous work, thus the effect would be to make this estimate higher than reality;

<u>Step Method</u>

The step method involved applying a per household cost of increasing the level of service for every step, to every household that requires the step. This method of analysis was used to generate the capital costs of bringing the entire population up to the full waterborne service level of service. The analysis was carried out using Census 2001 data.

Hence, the unit cost of bringing the representative population up to the Communal and Standpipe Level of service was calculated. This unit cost was then applied to the number of households on a national level that need to make this step. Then a unit cost of bringing the representative population up to a yard connection level of service was calculated, and thus unit cost was applied on a national scale to those who need to make that step. Similarly, cost of the step between year connections and house connections was calculated. The sum of the costs was then taken as the national cost.

The results of the analysis are shown below:

Table 37: National Cost Implications – Step Method

	Unit cost / house hold [R]	Sum of Total [HH]	Cost [R million]
No service -> Standpipe & Communal taps	7 730.68	1 619 518	12 519
Standpipe & Communal taps -> Yard Taps	3 520.44	2 432 118	14 263
Yard Taps -> House Connections	15 972.99	3 337 576	118 027
House Connections	0.00	3 811 830	0
	Totals :	11 201 042	144 811

The results of the model indicate that the total capital costs would be in the order of R145 billion. Interesting aspects of the model are that if the cost of the initial step of moving a population from no service to a basic level of service was 100, the cost to move up to yard taps would be an additional 45 points. The final step would be a further 207 points. Thus the decision which carried with it a large cost implication is whether to move from yard connections to full waterborne service. The decision with the second largest cost implication was made in 1994, to provide the population with a basic level of service. Moving to the intermediate level of service does not carry with it such weighty cost implications.

This methodology rests upon several assumptions, which are explained below:

1. The unit costs are based upon the representative population – that of the Ditsobotla Local Municipality. The municipality has a blend of urban and rural populations. The populations are neither as dense as city populations, nor are they are scattered as they are in rural areas of the Eastern Cape and KwaZulu-Natal. Possibly the model overestimates the final costs owing to a lack of recognition that economies of scale will bring to the unit costs for urbanised populations;

7. DISCUSSION OF RESULTS

7.1. Introduction

The literature review, the model development process and the model results allow a critical analysis of the implications of raising the basic level of water services. This analysis is carried out under four theme headings.

The first aspect is the costing of any proposed increase and the nature of change of costing of movement up the water services ladder. The second aspect is the areas of water services infrastructure that require attention in order to move up the water services ladder as cost efficiently as possible. The third aspect is the human resources requirements for moving up the water service ladder. The fourth aspect is general considerations with regards to aspects that cannot be directly modelled but which should be considered by policy makers when making decisions with regards to movement up the water services ladder.

This analysis is intended to discuss and highlight the major implications of moving up the water services ladder from a strategic water provision perspective – broader concerns such as the social impacts of such a move, political considerations to be taken into account, as well as macro-economic implications for the country's fiscus are outside the scope of the study and would have to be factored into the equation through further study.

7.2. Costing Implications

Progress up the Ladder

The model shows that the progress up the steps of the water ladder is not one of smooth transitions. Indications are that the following per household costs would be applicable:

Table 38: Cost Per Household of Moving up the Water Ladder

Water Ladder Step		Per Household Cost [R]
Starting Level of Service	**Ending Level of Service**	
No service	Standpipe & Communal taps, VIP latrines	7 730.68
Standpipe & Communal taps	Yard Taps, VIP latrines	3 520.44
Yard Taps	House Connections, Waterborne sanitation	15 972.99

South Africa had made the initial decision to make the first step on the ladder in 1994 and the decision to take subsequent steps has not been made. The model concludes that the taking of the next step to bring all households up to a Yard Tap level of service with a minimum sanitation level VIP latrines, would have half the cost implications of the 1994 decision.

In contrast, the step beyond this level, to house connections and waterborne sewerage would have significant cost implications.

In light of the cost increases for water services, the distribution of the burden to pay for these costs would have to be considered. Currently water services practice is to provide a free basic service. The level of this service – communal standpipes and 6 000l/hh/month, is provided for free – there is currently no need to differentiate between the basic service and the free aspect of the service. This situation is the result of the human rights consideration that the minimum quantity and quality of water supply should be free to all RSA residents.

In moving up the water services ladder, this separation would have to be made. Once the human rights requirement has been fulfilled, moving above this level could involve households shouldering some of the costs of the improved level of service. The literature review shows that one of the benefits of having water available is an improvement in health and therefore lifespan. The economic justification for improving water supply thus runs along the lines of it reducing the health care burden of the state as well as extending the productive lifespan of the population. This argument applies especially to the rural poor. However, once water supplies rise above what is needed to fulfil these economic arguments, water supply becomes a "normal" good that can be supplied at a cost; the use of the water derived for its users a benefit greater than the cost.

Thus the new basic level of supply need not be free. The free component could be left at the standpipe and 6 000l/hh/month level, whilst tariffs are charged for additional water supplies.

To take the line of reasoning further, it is necessary to examine the main cost drivers of waters services, as shown in the model.

The following Table presents a typical percentage cost breakdown for the various pieces of infrastructure for two scenarios.

Table 39: Water Services Component Costs Expressed as a Percentage of Total Costs

Infrastructure Component	% of total cost	
	Scenario 2c	Scenario 3a
Household sanitation	34.2%	35.5%
Internal reticulation	33.7%	28.4%
Water pipelines (bulk)	9.9%	6.1%
Sewage Treatment Works	7.5%	19.4%
Elevated storage	5.4%	3.4%
Metering	4.9%	3.0% *
Water Treatment Works	2.7%	0.2% *
Sewer pipelines (bulk)	1.2%	3.6%
Boreholes	0.6%	0.4%

* Scenario 3a excludes upgrading these items, so these figures are un-representative

The Table demonstrates that the major costs of both of these scenarios are the household level infrastructure components. Economies of scale apply to the larger, common use, infrastructure components. The household level infrastructures are the items whose primary purpose is to improve the quality of the service. To move from standpipes to yard taps, at the same volume of water supplied, will be far more expensive than to leave the standpipes in place and increase the volume of water supplied. Obviously the volume of water supplied will have an upper limit, beyond which larger supply pipes will have to be installed, but twenty-four hour off-takes can be carried out to great effect, to delay this step.

Thus, it is submitted that the increase of the volume of water does not incur the main costs. The major costs are incurred for the improvement of the physical infrastructure necessary to increase the quality of the service. Therefore it is possible to increase the free basic volume of water, but not to increase the free basic quality of water service. It is the quality of service improvements that would require household financial participation, not an increase in the free basic volume of water.

In this light, the concepts of free and basic water should be separated. The free water supply could be moved up to standpipe connections and a higher volume of water service. The basic water supply could be set to yard connections and VIP latrines for example. Funding for this supply would have to be sourced, at least partially, from affected households.

Owing to the requirement for greater financial participation from households in the provision of water services, the setting of a national policy with regards to the basic water supply is seen to be counter-productive. Improvements in the basic water supply should be made in consultation and participation with communities, the results of this consultation will not be uniform across the country. Various factors will influence community decisions – not least of which are the costs of improved supply, but this would include raw water availability and the other uses to which water could be put at household level. Hence a single basic water services standard would run the risk of not obtaining household participation. Thus the costs will fall to external sources of funding – either cross-subsidisation or from the treasuries of the various tiers of government. Once this occurs, and the users of the water services do not want to be financially invested in the supply, the question will arise as to whether other uses for the external funding might be more productive.

A distinction should be made between beneficiary's preferences for improved supply and their need for an improved supply. It is accepted that beneficiaries' needs have been catered for by the existing free basic supply. If this is not the case, then the allowance for household volumes could be increased at low cost, but the quality of supply would remain at standpipe level. Further steps up the water services ladder have more to do with beneficiary preferences than needs.

Affordability of Progress up the Ladder

Affordability of the progression up the ladder is a major consideration. This is in addition to other environmental considerations that are discussed in Section 7.4.

The model indicates the following national level costs for moving up the water services ladder.

Table 40: National Capital Costs for Moving up the Water Ladder

Water Ladder Step		National Capital Cost [R million]
Starting Level of Service	Ending Level of Service	
No service	Standpipe & Communal taps, VIP latrines	12 519
Standpipe & Communal taps	Yard Taps, VIP latrines	14 263
Yard Taps	House Connections, Waterborne sanitation	118 027
	Total :	144 811

These figures are taken from the Step Method in Section 6.2.7. The total cost from the Roll-Up Method in Section 6.2.7 is R107 192 million, a result that uses more detail in the calculation, and is thus preferable. The Roll-Up Method, however, does not provide information in a step-wise fashion.

Using the Roll-Up Method figures, annual costs are also derived. These costs, using a discount rate of 8% over 25 years, result in a Present Value of the annual costs of R307 221 million. Thus a total cost of some R414 billion can be expected from the decision to increase the level of service to a full water-borne service. South Africa's 2010 Gross Domestic Product is R2 699 billion (National Treasury, 2010). Thus the proposed cost is 15% of the annual Gross Domestic Product. The actual cashflows arising from this proposal would be spread over 25 years or more. A crude estimate of the quantum of this cashflow, would be approximately 0.6% of the GDP.

Expressed as a percentage of the central government revenue in 2010, the following figures are derived. Revenue in 2010 was R643 billion, thus this proposal is equal to 64% of central government annual revenue. The crude estimate of expenditures over a 25 year period indicates expenditure for the proposal at 2.6% of annual revenue.

Expressed as a percentage of the total water service sector investment budget of R5 billion annually, the crude annual costs amount to 331% of the current budget. Hence a tripling of the current investment expenditure in the sector would be called for over the next 25 years.

Clearly this proposal carries with it significant cost implications that will have to be weighed by policy makers.

In contrast, a proposal to step up to the yard connection and VIP latrine level of service the capital cost would be approximately R27 billion. Taken over a notional period of ten years to complete the capital expenditure, this cost would be 54% of the current investment in the water services sector – a large, but more manageable, proposition.

7.3. Infrastructure Components Implications

In order to move up the water services ladder, the literature and model refer to various standard pieces of infrastructure. For this purposes of this discussion, these are listed below, in no particular order:

- Internal reticulation;
- Storage;
- Water pipelines (bulk);
- Boreholes;
- Water Treatment Works;
- Metering;
- Management;
- Household sanitation;
- Sewer pipelines (bulk); and
- Sewage Treatment Works.

These items will be used in the discussions below.

Component Design and Cost Optimisation

As previously discussed the major cost components are at the household level: internal reticulation; household sanitation; and metering.

Given that annual renewal costs and maintenance costs are proportional to the capital value of the components, a large percentage of the annual costs is dependent upon the initial capital values.

This analysis therefore supports the conclusion that design improvements made at the household level are critically important to the overall financial sustainability of moving up the water ladder. Linked to this conclusion is that design improvements should have their primary aim of reducing maintenance costs and improving lifespans. Previous sections of this Report have demonstrated that annual costs over a 25 year span are more than double the initial capital costs, therefore improvements to the life of the infrastructure and design improvements that reduce the maintenance requirements will yield significant dividends.

Examples could include low-maintenance VIP latrines, using more robust reticulation pipes to ensure longer lifespans, and designing meters to be simpler and less operationally intensive. Possible re-designs to taps, valves and other plumbing items should be considered to make them more robust and less susceptible to theft. It is possible that faulty plumbing items, in particular, are the cause of many maintenance issues, and that the use of higher quality fittings during the construction phase will yield great benefits. In mass community projects it is suggested that the beneficiaries be engaged on aspects such as proper use, vandalism and theft – improvements in these areas will all contribute to reduced annual costs of the infrastructure.

Lumpy Nature of Component Improvements

Owing to the nature of the various components, moving up the water ladder does not require simultaneous improvements in all aspects of the infrastructure. This view is confirmed by the literature review and is shown in the model.

Steps taken up the ladder at the low levels of service, for example moving from standpipe connections to yard connections, result in improvements to the internal reticulation and bulk water pipelines. Reticulation improvements are generally focussed on the extension of the network to erf portions, rather than the re-sizing of truck mains. Bulk water pipelines in this case would have to be re-sized and this cost reflects in the model.

When moving to a higher level of service, the sanitation costs become proportionality more significant, whilst waste water treatment and operations becomes a large cost and human resources' burden.

Thus moving up the ladder involves waves of construction in specific areas of infrastructure. This wave nature of improvement should be encouraged since contractors and suppliers are able to gear up for large volumes of specific types of construction and the supply of specific pipe sizes ,for example, that will yield cost savings and speed improvements as the wave advances.

7.4. Human Resources Requirements

The literature and the model show that human resources requirements to enable a move up the water services ladder are key to success. The infrastructure being instated represents a significant investment and the annual costs of operating this infrastructure are significant. Operations and maintenance skills that are able to extend efficiently the use of the infrastructure will make significant national cost savings.

The additional human resources required for a move to a full waterborne level of service is estimated at 13 400 people required to actually operate and maintain the infrastructure. This figure does not include the necessary supply staff to sustain this level of employment. This is in addition to the 40 000 people estimated by the model required to service the 2001 infrastructure. Note that a DWAF estimate published in 2003 gave a figure of approximately 70 000 people (DWAF, 2003) employed in the water services sector.

The Table below summarises the total human resources requirements for the move to a full level of service.

Table 41: National Human Resource Requirements

Province	Total Human Resources Estimate
Eastern Cape	7 644
Free State	3 583
Gauteng	8 438
KwaZulu-Natal	11 143
Mpumalanga	3 981
North West	5 384
Northern Cape	1 892
Limpopo	6 508
Western Cape	4 857
South Africa	53 428

The Eastern Cape, KwaZulu-Natal and the North West Province have large rural populations and thus have high human resources requirements. These provinces will need to be concentrated upon to ensure that the requisite technical and managerial skills are produced and remain in these areas for the steps up the water ladder to be successful.

A skilled human resource base is essential to ensure that the full lifespan of the infrastructure is realised. A lack of regular maintenance by skilled personnel will reduce the economic life of the infrastructure. This has very serious negative implications for the lifecycle costs of moving up the water services ladder.

7.5. Sewerage and Grey Water Return Flows

The model contains an estimate of the sewerage and grey water return flows that are generated by step up the water services ladder.

The Table below details the combined return flows for the various levels of service.

Table 42: Combine Return Flows for Various Levels of Service

Water Ladder Step		Average Water Demand [kl/hh]	Average Return Flow [kl/hh]
Starting Level of Service	Ending Level of Service		
No service	Standpipe & Communal taps, VIP latrines	14	5
Standpipe & Communal taps	Yard Taps, VIP latrines	15	5
Yard Taps	House Connections, Waterborne sanitation	34	30

Return flows for the first two steps are relatively low proportions of the total water demand for the first two steps up the water services ladder. These figures are because most of the households in the sample have a VIP latrine level of service, while the remaining population, with a higher level of service is contributing via conventional sanitation flows. Hence the total flow is biased towards grey water at these low levels of service.

At the highest level of service, conventional sanitation services contribute to a higher per household flow, and the total flow will be biased towards sewerage flows and away from grey water.

The handling of grey water for low levels of water service is an aspect that requires attention. Grey water flows from kitchen sinks, baths and other non-sanitation household flows. Typically this flow will drain and collect at the service point, run out into the road or adjacent property, or be disposed of out of the house into the garden/road. These flows and stagnant areas cause health concerns and serve to erode the topsoil of the area. One of the objectives of moving up the water service ladder is to improve the health of the population, thus is does not make sense to reverse these gains by creating a new health hazard close to houses. Topsoil erosion reduces the productive capacity of land, as well as increasing eventual treatment costs for raw water in rivers. This is separate from the ecological concerns associated with erosion.

Grey water handling could be achieved by installing engineered soakaways at each terminal point. These soakaways should be robust and maintenance free and householders should be informed with regards to regular maintenance required. Approaches such as encouraging kitchen gardens in areas suitable for agricultural production should be attempted to increase the amount of grey water re-used in households.

At the highest level of water services, return flows will be mainly owing to sewerage flow. These flows should be reduced as far as possible to ensure the maximum life from the installed pipes and waste water treatment plants, as well as to reduce the costs of operations. Hence it is suggested that grey water management process be put in place in all areas which receive full water-borne sewerage.

7.6. Institutional Requirements

A growth in the water services network, along with the operational and maintenance requirements that this network will bring, will places stress on existing water services Institutions.

Areas of institutional capacity that should be enhanced include addressing existing financial constraints by ensuring that any expansion is adequately funded both for capital and operational expenses.

Planning for cost recovery from communities should be improved to ensure that the greater expenses incurred by moving up the water services ladder are funded. It is submitted that this aspect is the most crucial aspect of the entire proposal to move up the water ladder.

Sub-economic tariffs create long term unsustainability and doom a project to decay and the resultant wasted expenditure.

Operational matters such as unmetered consumption and water leakage through the system should be addressed institutionally. Both of these items serve to weaken the financial sustainability of the water services system and need to be addressed through robust, but fair, community interventions and through adequate maintenance supervision of the networks.

Human resource management at Institutions should be such that an Institution is capable of attracting and retaining technical and managerial skills that are capable of planning effective operation and maintenance activities. The capacity to plan, develop and fund infrastructure will be a key output of the management of every waters services Institution.

7.7. Research Needs

The research has highlighted a number of areas that would have to be more fully investigated in order to improve the accuracy of the current research as well as to more fully cover conclusions of this research. Both of these will provide decisions makers with the information needed to make a decision on the way forward.

The first additional area of is to update the model using the 2011 Census results and expand the model to include all sub-places in the country. The model included in this report uses Census 2001 data which data was ten years old at the time of the report. Increasing the standard of water services to all South Africans has received a great deal of emphasis during the intervening ten years and hence future models should take this progress into account. The national level conclusions included in this report were based upon extrapolation of model results in the Ditsobotla Local Municipality.

The future research should re-run the model using the Census 2011 results and for all sub-places in the country. This would yield costs that fully take into account the latest reliable information on progress up the water services ladder made to date and will include the conditions prevalent in all sub-places.

The second area of additional research would be into household level affordability of increased levels of water service. All movement up the water ladder would have to be financially sustainable and the major aspect of this is the user’s ability to contribute towards the costs of the enhanced service. The study would derive an affordability map across the country, taking into account the current household income, the estimated future tariff and hence present an affordability metric. The study would present options for funding the full costs of the service for various household income levels, the rural/urban split between households and the suitability of a partially non-user funded tariff. The study would also investigate current household attitudes to payment for enhanced water service.

A third area for future research would be to investigate the human capital requirements to ensure that any move up the water services ladder is sustainable. The present research provides the number of operational staff that is required. The future research would expand this research to investigate the workforce to determine if the numbers required can be supplied. Should the current workforce be deficient in suitable candidates, the research would investigate tertiary education and training to determine whether that gap can be filled. The conditions necessary to fill the gap, as well as the requirements that need to be met by the education and training sector would form important conclusions of this research.

A forth area for research would be household and institutional attitudes and impediments to payment for services. A constant theme throughout the study was that households refuse to pay and that payment for service delivery was a lost cause. The researchers are of the opinion that this refrain has become self-fulfilling, to the detriment of better services for all South Africans. The research would examine reasons for non-payment, and impediments to payment, by households. It would further examine examples of success and failure of service payment schemes and derive the lessons learnt. The research would also investigate institutional and local political attitudes and impediments to service delivery payment. The research would draw conclusions and make recommendations which would make significant progress towards solving this apparently intractable problem.

8. CONCLUSION

In summary, the report has derived the following conclusions with regards raising the basic level of water service.

At a local level of modelling, service levels up to yard connections are relatively inexpensive; the jump to house connections and particularly household level water-borne sewerage causes the costs to escalate by a factor of 2.5 and the human resource implications by a factor of 10. Metering is a major cost driver at all levels of service, but is necessary to control water consumption and recover the costs of supply. With regards the household level notional cost of service; for a full household level service to be provided, the notional per household cost will be three times that if only yard connections and dry sanitation is provided. Water consumption levels in this case would double.

Funding this additional burden would fall directly on the benefitting households, or though some form of subsidised funding. In the former case, an increase in monthly household charges would have to be canvassed with the benefitting households – it cannot be a cost that is imposed. In the latter case, funding for the costs of the increase in the level of service would compete with other funding priorities, a decision that would have to be taken by the society as whole, with a full understanding of the large and on-going costs of such a decision.

The model provides cost breakdowns on the infrastructure components that will be most capital intensive. A list of these capital costs are: providing sanitation reticulation, waste water treatment works, water metering and the costs of internal water reticulation – all in decreasing order of cost contribution. Bulk water and sewer mains and raw water treatment works are relatively small when compared to the four components mentioned earlier.

The model also provides cost breakdowns on the infrastructure components that will be most operations and maintenance intensive. A list of these costs are: internal water reticulation, and sanitation reticulation components – in decreasing order of cost contribution. By comparison, the operations and maintenance costs of waste water treatment works, bulk water and sewer mains and raw water treatment works, metering and raw water treatment works are relatively small.

The results of a national scale analysis show that bringing every household in the country up to a level of full household connection and waterborne sewerage, from the status quo in 2001, was estimated at between R110 billion and R145 billion.

Once this infrastructure has been constructed, the annual costs of servicing and maintaining it would be in the order of R26 billion. If a discount rate of 10% is chosen, the present value of the annual operations costs for the next 25 years will be R265 billion. If a discount rate of 8% were to be used the present day cost would be R307 billion. These costs should be added to the capital cost to arrive at a total figure for the present day estimate of the cost of bring all of the population up to a full water-borne level of service.

The model also demonstrates that an additional 11 000 water services personnel would have to be employed countrywide. These are permanent positions and do not account for the positions created during the construction phase of the national roll-out.

The model also showed that the cost of the initial step of moving a population from no service to a basic level of service was 100, the cost to move up to yard taps would be an additional 45 points. The final step would be a further 207 points. Thus the decision which carried with it a large cost implication is whether to move from yard connections to full waterborne. The decision with the second largest cost implication was made in 1994, to provide the population with a basic level of service. Moving to the intermediate level of service does not carry with it such weighty cost implications.

The model shows that the progress up the steps of the water ladder are not made in smooth transitions. The steps up the water ladder would be very lumpy, requiring careful affordability and sustainability considerations at every step.

In light of the lumpy cost increases, the distribution of the burden to pay for these costs would have to be considered. Currently, the basic level of water services is also the free level, in the future a separation between these two would have to be made. The economic justification for improving water supply runs along the lines of it reducing the health care burden of the state as well as extending the productive lifespan of the population. This argument applies especially to the rural poor. However, once water supplies rise above what is needed to fulfil these economic arguments, water supply becomes a “normal” good that can be supplied at a cost; the use of the water derived for its users a benefit greater than the cost. Thus the new basic level of supply need not be free. The free component could be left at the standpipe and 6 000l/hh/month level, whilst tariffs are charged for additional water supplies.

The report demonstrates that it is possible to differentiate between the volumes of the water supplied, and the quality of service. Increases in the quality of service are resource intensive, whilst modest increases in water volumes are not. Therefore it is possible to increase the free basic volume of water, but not to increase the free basic quality of water service. It is the quality of service improvements that would require household financial participation, not an increase in the free basic volume of water.

The report recommends that the concepts of free and basic water should be separated. The free water supply could be standpipe connections and a higher volume of water service. The basic water supply could be set to yard connections and VIP latrines for example. Funding for this quality of supply would have to be sourced, at least partially, from benefitting households.

Owing to the need for greater financial participation from households in the provision of water services, the setting of a national policy with regards the basic water supply is seen to be counter-productive. Improvements in the basic water supply should be made in consultation and participation with communities, the results of this consultation will not be uniform across the country, with various factors influencing community decisions. Thus communities should have the power to determine which volume and quality of service they want, and be presented with, and undertake to settle, the costs of the chosen level of service.

The report draws conclusions on the affordability of increasing the basic levels of water services. The total cost to provide a full water and sanitation level of service over the next 25 years is expected to be in the order of R414 billion. This is 15% of South Africa's 2010 annual Gross Domestic Product or, using crude estimates 0.6% of GDP on an annual cashflow basis. If it is assumed that all of the costs would fall to central government, these figures represent 2.6% of annual government revenue. The report submits that this burden would be unfavourably compared to other requirements for funding and would thus be unaffordable. In contrast, a proposal to step up to the yard connection and VIP latrine level of service would be dramatically lower and would represent a large, but more manageable, proposition.

The report provides details on which other implications would need attention should a decision be made to increase the level of service. These include the fact that design improvements made at the household level that reduce the overall cost of ownership are critically important to the overall financial sustainability of moving up the water ladder.

Moving up the ladder involves waves of construction in specific areas of infrastructure. This wave nature of improvement should be encouraged since contractors and suppliers are able to gear up for large volumes of specific types of construction and material supply that will yield cost savings and speed improvements as the wave advances.

The literature and the model shows that human resources requirements to enable a move up the water services ladder are keys to success. A skilled human resource base is essential to ensure that the full lifespan of the infrastructure is realised. A lack of regular maintenance by skilled personal serves to reduce the economic life of the infrastructure, which has very large implications for the lifecycle costs of moving up the water services ladder.

A growth in the water services network, along with the operational and maintenance requirements that this network will bring, will places stress on existing water services institutions. Areas of institutional capacity that should be enhanced include addressing existing financial constraints, planning for cost recovery from communities. Sub-economic tariffs create long term unsustainability and doom a project to decay and the resultant wasted expenditure. Operational matters such as unmetered consumption and water leakage through the system should be addressed institutionally. Both of these items serve to weaken the financial sustainability of the water services system. Human resource management at institutions should be such that an institution is capable of attracting and retaining technical and managerial skills.

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